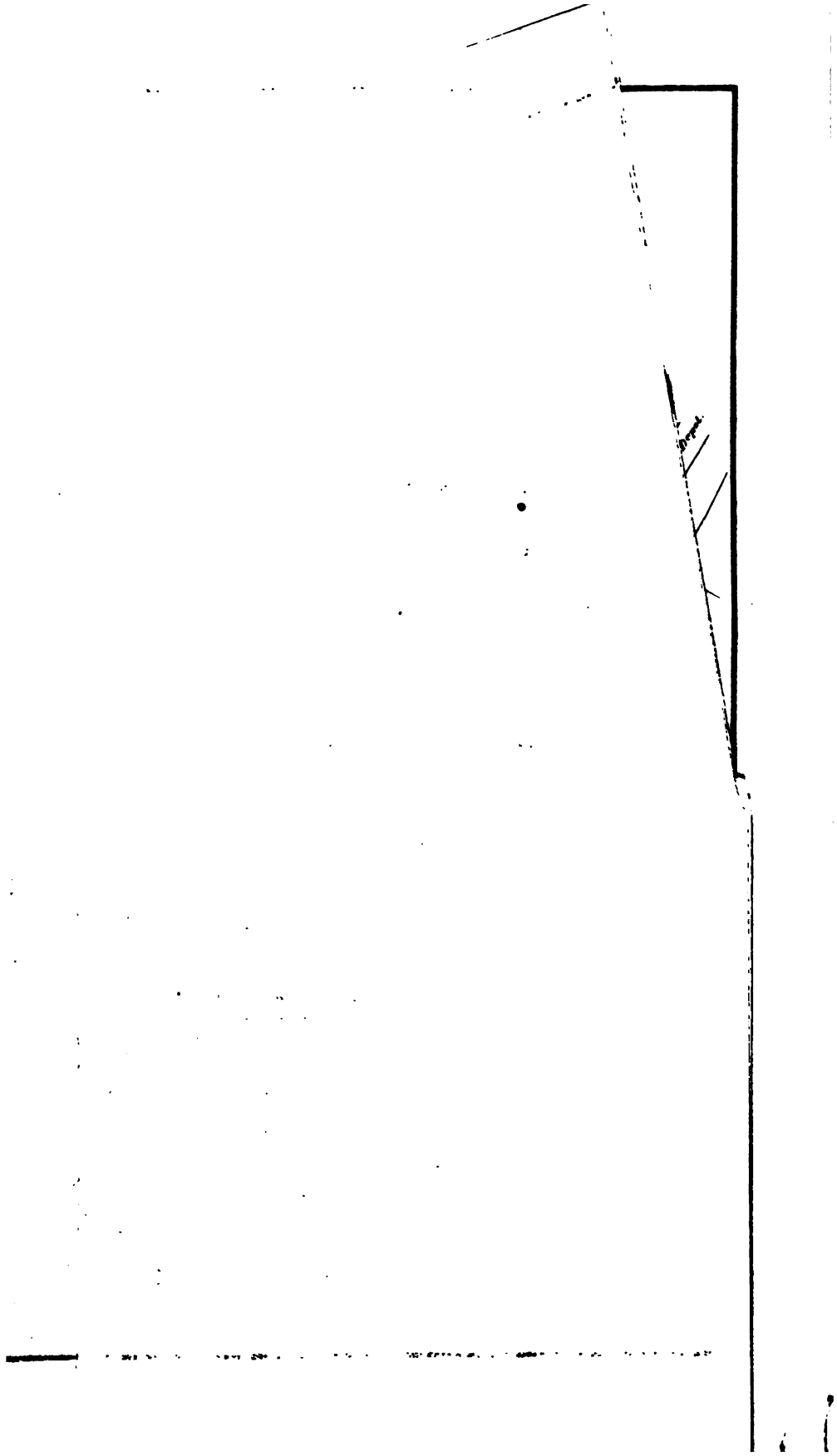
Boston Transit Commission.

First Annual Report.

August 15, 1895.



FIRST ANNUAL REPORT

OF THE

BOSTON TRANSIT COMMISSION,

FOR THE YEAR ENDING

AUGUST 15, 1895.

FROM

THE BOSTON TRANSIT COMMISSION,

20 Beacon Street.

GEORGE G. CROCKER, *Chairman,*

CHARLES H. DALTON, GEORGE F. SWAIN,

THOS. J. GARGAN, ALBERT C. BURRAGE,

Commissioners.

HOWARD A. CARSON, *Chief Engineer.*

B. LEIGHTON BEAL, *Secretary.*

BOSTON:

ROCKWELL AND CHURCHILL, CITY PRINTERS.

1895.

BOSTON TRANSIT COMMISSION.

20 Beacon Street,
Boston, August 15, 1895.

To the City Council of the City of Boston:

In compliance with Statutes 1894, chapter 548, section 24, the report of the Boston Transit Commission for the year ending August 15, 1895, is respectfully submitted.

Section 23 of that act provides that the Governor shall appoint, with the advice and consent of the Executive Council, two discreet persons, who, together with the persons appointed under chapter 478 of the Acts of 1893, shall constitute a board to be known as the Boston Transit Commission, and shall hold office for a term of five years from the date of the passage of the act.

The act was approved July 2, 1894, and was accepted at a special election held July 24, 1894.

On July 26 the Governor, Frederic T. Greenhalge, appointed Messrs. George G. Crocker and Albert C. Burrage as members of the Commission in accordance with the provisions of the act, and these nominations, under a suspension of the rules, were approved by the Executive Council on the same date.

The Commissioners who had been appointed under the provisions of chapter 478 of the Acts of 1893 were Messrs. Charles H. Dalton, Thomas J. Gargan and George F. Swain.

The Boston Transit Commission organized August 15, 1894, by the choice of George G. Crocker as Chairman.

On August 30, 1894, Howard A. Carson, Civil Engineer, was appointed Chief Engineer for the Commission. Mr. Carson had been Chief Engineer of the Metropolitan Sewerage Commission since its organization, and his work for that Commission was approaching completion.

At the same time Henry H. Carter, Civil Engineer, then the Superintendent of Streets of the city of Boston, was appointed a Consulting Engineer.

On October 1 Mr. B. Leighton Beal was appointed Secretary.

HISTORY OF THE ACT CREATING THE COMMISSION.

The creation of the Boston Transit Commission was the outgrowth of an agitation extending over many years.

In June, 1891, the Rapid Transit Commission, under legislative authority, had been appointed to deal with the whole problem of rapid transit to and in the city of Boston. That Commission consisted of His Honor the Mayor, Nathan Matthews, Jr., and the City Engineer, William Jackson, ex-officiis; Messrs. John Quincy Adams, Chester W. Kingsley and Osborne Howes, Jr., appointed by the Governor, and Henry L. Higginson, James B. Richardson and John E. Fitzgerald, appointed by the Mayor. It gave fifty-one public hearings, and employed numerous engineers and experts. The cost of its investigations amounted to about $50,000. After nine months of laborious study it made an extended report in April, 1892, recommending various changes with reference to the steam-railroad terminals, among which was the building of a union station for the roads on the northerly side of the city; and it also recommended the development of two routes for traffic through the city, one on the east side of Washington street, and the other along the line of Tremont street.

On the east side the Commission recommended the construction of an elevated railroad, and along the Tremont-street route a subway or tunnel.

The Legislature of 1892, to which this report was submitted, referred the matter to the Legislature of 1893.

By the Legislature of 1893 a special committee of fifteen to consider the subject was created. The hearings of this committee were continued for several months. There were forty hearings in all, and the questions involved were extensively discussed in the public press.

Two acts were passed. The first (Statutes 1893, chapter 481) provided for the creation of the Metropolitan Transit Commission, and required that Commission to take a strip of land from Causeway street to Franklin Park for a new way which, through the heart of the city, was to run between Washington street and Tremont street. This plan became known as the "Alley" route. The act was not to become operative unless approved by a majority of the voters of the city of Boston voting at a State, municipal or special election. Official estimates of the cost of this plan were made during the summer and fall of 1893 and published. (See City Doc. No. 145 — 1893.) The act was rejected by the citizens of Boston at the State election.

The other act passed by the Legislature of 1893 (Statutes 1893, chapter 478) provided for the creation of a Board of Subway Commissioners with authority to construct a subway or subways from a point or points near the junction of Tremont and Pleasant streets to an exit in Scollay square or that vicinity. This act was not to take effect unless adopted by the City Council of the city of Boston. The "Alley" plan having been rejected at the State election, the act providing for the appointment of a Board of Subway Commissioners was shortly thereafter approved by the City Council of the city of Boston, and on the 1st of January, 1894, Charles H. Dalton, Thomas J. Gargan and George F. Swain were appointed members of the Commission.

On February 12, 1894, this Commission made a report or statement (see Appendix A) to the Legislature calling attention to defects in the act. The chief defects noted were the following, viz.:

First. That the location of the northerly outlet, namely, Scollay square or its vicinity, was unsuitable, inasmuch as the congestion at that point and northerly thereof would not be relieved.

Second. That no provision was made for access to the subway for cars coming into the city over Boylston street and Columbus avenue.

The Subway Commission recommended that the act be amended so that power should be given to build a subway for four tracks from Pleasant street to Causeway street with a branch running through Boylston street to an outlet or outlets in the vicinity of Park square, and further that permission be given to locate stations under the malls on Tremont and Boylston streets. The cost of construction was estimated at three and a half million dollars and the land damages at one and a half million dollars, making a total of five million dollars.

A Joint Special Committee on Transit, consisting of fifteen members, gave fifteen hearings on the subject, and there were in addition thirteen hearings before the Committee on Finance. The recommendations of the Commission, with modifications and additions, were finally incorporated in a composite act (Statutes 1894, chapter 548), the first half of which provided for the incorporation of the Boston Elevated Railway Company, and the last half of which provided for the creation of the Boston Transit Commission. The two parts of this composite act had no necessary connection with each other. The building of the elevated railroad was not in any way made dependent upon the building of the subway, nor was the building of the subway made dependent upon

the building of the elevated road, and the routes of the two were not the same.

The powers given to the Commission by the act were in some respects greater than had been asked by the Subway Commission. The act authorized the Commission, but did not require it, to build a subway or subways between Pleasant street on the south and Causeway street on the north, with a branch to Park square, or to an outlet or outlets in that vicinity, and it also gave power to build a tunnel under Beacon Hill, a tunnel from the vicinity of Scollay square to East Boston, and to lay out a new way from a point near the junction of Shawmut avenue and Tremont street to Franklin park. The limit of expenditure was fixed by the act at seven million dollars.

The act further required the Commission to construct a bridge over Charles river between the present Charles-river bridge and the Fitchburg Railroad bridge, and the Commission was authorized in the construction of said bridge to expend, in addition to the seven hundred and fifty thousand dollars previously appropriated therefor by the City Council of the city of Boston, such further sums as might be necessary for the completion of the bridge and approaches.

THE SUBWAY.

Under the discretionary power vested in the Commission, it was necessary to study the transit problem; to consider the merits of the various plans which had been proposed; to seek new and better methods, if any could be found, and, after weighing the advantages and disadvantages of each proposition, to determine whether it was expedient to build a subway within the limitations of the act.

In making this study, plans and statistics already accumulated were examined, and additional information was obtained as to the elements of the problem, especially as to the amount and characteristics of the traffic, and the engineering work necessarily preliminary to the building of a subway was pushed forward.

This engineering work may be classified as follows:

First. Surface surveys were made locating the buildings, vaults under sidewalks, manholes, poles, surface tracks, and all other surface objects along the proposed route of the subway.

Second. Sub-surface surveys were made by borings and by excavations or tunnels. Sixty-seven borings, in addition to the eighteen previously made under authority of the Subway Commission, were made along the line of the subway at

intervals of from 25 to 200 feet, showing the precise character of the ground to be excavated in each portion of the route. In making a boring, a sample of each stratum passed through was preserved and duly labelled so as to show the location of the boring and the depth at which the sample was taken. The data obtained from the borings were also duly plotted on plans. Excavations have been made in nearly every cellar along the route in order to determine exactly the character and dimensions of the foundations, and other excavations or tunnels have been carried under the streets at certain points to determine the precise arrangement and location of pipes, sewers, conduits and other sub-surface obstructions. This information was additional to that obtained in the office of the City Engineer. From the data thus acquired cross-sections of the streets were drawn showing the character and dimensions of the foundations on each side, together with the position and size of pipes, sewers, etc.

Third. Detailed studies were made with regard to the methods and cost of caring for and making disposition of such pipes, sewers and conduits as may be interfered with in the construction of the subway.

Fourth. Studies and estimates were made of various methods of construction involving many matters of detail with reference to materials, dimensions, etc.

A REVIEW OF THE CHIEF REMEDIES PROPOSED FOR THE RELIEF OF THE TRANSIT CONGESTION.

I. *The Alley Plan.*

One scheme proposed, perhaps the most popular, was to lay out a new central avenue, 25 feet wide, between Washington and Tremont streets, — known as the "Alley" route, — in which should be concentrated all the street-car traffic of the adjacent congested district.

The official estimate of the damages for land and buildings in laying out such a street from Court street to the junction of Shawmut avenue and Tremont street was over $6,000,000. As the street would only be wide enough for two tracks, and as more than two tracks would be needed to accommodate the traffic, it would be necessary to have tracks on two levels; and inasmuch as tracks on the surface would cross at grade Eliot street, Boylston street, West street, Temple place, Winter street, Bromfield street and School street at points midway between Tremont street and Washington street, these tracks and the streets as well would be blocked.

It is evident that this 25-foot way would not accommodate the street-car traffic unless a two-story elevated road were built in it, or an elevated road and a subway. The cost of constructing these would be additional to the six million dollars for opening the avenue. Not only was this plan objectionable on account of its cost, but it was also objectionable because so large a portion of the expenditure was for property actually destroyed.

Under this plan the public would take and leave the cars on one street instead of several, and its natural effect would be to contract rather than to enlarge the business district. This "Alley" plan was rejected by the citizens of Boston at the State election in 1893.

II. *Widening of Tremont Street.*

The other methods of relief contemplated treating the Tremont-street traffic by itself and the traffic on Washington street and other streets east of Washington street by itself. The most obvious method of dealing with the Tremont-street traffic, and the method most consistent with precedent, was to widen the street. On the widened street the cars would be less subject to blockades, but the additional accommodations thus furnished would give relief for a brief period only. In order to get increased accommodations adequate to meet present wants satisfactorily, it would be necessary to lay additional tracks in such widened street. These tracks would give increased accommodations, but such accommodations would be subject to disadvantages similar in kind to those under which the surface-track traffic is now carried on.

In the heart of the city, no matter how wide the streets, it is impossible with surface tracks to secure the great desiderata, — relief from noise, freedom from blockades, speed and safety. Speed and safety cannot be secured with two tracks on the surface; with four tracks the speed of the cars on each track would be less rather than greater, and the danger of accident would be increased.

The estimates of the cost of building the subway indicate that, if the damages for land and buildings taken to widen the streets would amount to as much as twenty-five dollars per square foot, the cost of widening would be more than the cost of building a subway of equal width under the streets. The average assessed value of the land along the route of the subway, from one end to the other, is about $30 per square foot, which valuation does not include the value of the buildings. On those portions of Boylston and Tremont streets

where such streets could be widened by taking a portion of the Public Garden and the Common it would be less expensive to widen the streets than to build a subway, but in no portion of the route would surface tracks on widened streets furnish adequate and suitable accommodations. It may be wise to widen Tremont street for the purpose of securing a broader roadway for vehicles and a more adequate sidewalk, but considerations of economy and serviceableness do not support the plan of widening that street for the better accommodation of surface cars.

III. *Street-car Tracks on the Common.*

Various schemes for placing street-car tracks on the Common, either on the surface or in an open trench, or partly in a tunnel with frequent openings, and also with overhead bridges and underground passages for pedestrians, have been proposed in recent years.

Aside from the inadequacy of all such plans for accomplishing the various results sought for, the controlling sentiment of the citizens of Boston, and of large numbers throughout the State, is distinctly opposed to allowing any such use of the Common.

Beside the esthetic injury, the danger of accidents and inconvenience to people on foot would rather be increased than diminished, the crossing at Charles street at grade would not be abolished, surface tracks would still cumber the street at the junction of Boylston and Tremont streets, and north of Park-street church the tracks would remain on the surface unless a cut should be made upon the Common in that vicinity for an incline to a subway running from that point north, or a structure raised for connection with an elevated system.

IV. *No Through Cars, but a Separate Shuttle Line of Cars Running from Park square to Scollay Square.*

Another plan which, from time to time, has had many advocates is to stop at Park square the cars coming from the south and west, and at Scollay square the cars coming from the north, allowing an independent line of cars to run between these two points. This plan, if carried out, would not improve but would impair the circulation through the centre of our city, and would further increase the congestion at the points where the cars were looped or switched back. For people coming into the city from the north, and for those coming in from the south and west, the change of cars to the

shuttle system would be a constant barrier to prevent them from coming together.

In addition to these schemes, all of which contemplate the use of surface tracks, were two plans, one proposing an elevated road and the other proposing a subway.

THE MERITS OF A SUBWAY.

First. The subway destroys but little property. The widening of streets renders necessary the destruction of much property.

Second. The subway eliminates the danger which pedestrians now encounter in crossing tracks. In widened streets this danger would not be obviated.

Third. The subway increases traffic capacity by removing from the surface one important class of traffic. A street from which street cars are excluded is more useful and more safe, both for pedestrians and for vehicles, than a widened street would be with cars on the surface. The wider the street and the greater the amount and variety of traffic thereon, the more difficult and dangerous it is to cross.

Fourth. The subway relieves the streets from the posts and the network of wires necessary in the overhead trolley system. These posts and wires make the street less attractive. They are a source of danger to those passing underneath, and they increase the difficulties of the Fire Department.

Fifth. The subway relieves the street of the noise of the street car, the rumble and jar of the wheels, the hum of the motor and the clang of the bell.

Sixth. The subway renders it possible to run cars between stations at speed and with safety. Speed and safety are not possible on the surface, no matter how wide the street. The frequency of cross streets in the heart of the city renders this statement true, even if between the cross streets a space is reserved for the sole use of the cars.

Seventh. In the subway it is possible, by the use at junction points of a sub-subway, to avoid the crossing of one track at grade by another track for cars going in an opposite direction. This arrangement avoids the danger of collision, avoids delay, and increases the capacity of each track. The elimination of crossings at grade is not so practicable under any other system. The subway gives the largest traffic capacity per track.

Eighth. The descent to the station platform of the subway is less than the ascent to the platforms of the New York elevated system. The proposed platforms of the sub-

TREMONT STREET, OPPOSITE PARK-STREET CHURCH, DURING A CAR BLOCKADE, JULY 12, 1895.

way are 16 feet below the surface. The minimum height of the platforms of the New York elevated road is 19 feet.

Ninth. The estimates indicate that, on the route of the subway, it will be cheaper to build a subway than to widen the streets by the width of the subway.

Tenth. The subway will increase several fold the capacity for street-car traffic through the city, and will at the same time relieve other traffic on the streets from the interference to which such traffic is now subjected by the street cars.

Eleventh. In pleasant weather it is preferable to take the cars and ride in them on the surface rather than in a subway. On the other hand the subway will be preferable in stormy weather or in excess of cold or heat. In a subway lighted by electricity, and in which electricity is used as a motive power, the air can be kept pure and equable in temperature. If it were proposed to use fuel-consuming locomotives the subway plan would not be so desirable.

Twelfth. In the maintenance of a subway and in the operation of cars within it there are several items of saving in expenditure for repairs and operation, namely:

(*a.*) Maintenance of track, roadbed and electric line. The track in the subway may be constructed like an ordinary steam-railroad track. It will be accessible in all parts, the joints may be kept up, and the cost of repairs, as well as the loss by depreciation, will be much less for this portion of the road than if the tracks were laid on the surface of the street surrounded by pavement. The electric line equipment will also be less costly, less liable to injury from exposure to snow, sleet and rain, more easily accessible for repairs, and not subject to interruption in case of fires or other contingencies.

(*b.*) Removal of snow and ice. The portion of the road within the subway will not be subject to obstruction by snow and ice, and the cost of removing the same will therefore be saved. It will only be necessary to keep the entrances clear.

(*c.*) Saving in power. On account of the fewer stops and the better track the power required in moving cars through the subway will be less than in moving them on the surface.

(*d.*) Saving in time. With the present congested condition of our streets, the slow rate of speed of cars through the length covered by the subway, and the large amount of time consumed in stopping, both to take on passengers and on account of obstructions, a large amount of time is lost. In the subway these stoppages and obstructions will be largely or entirely eliminated, and there will therefore be a

greater amount of business done by each car in the same time.

(*e.*) Saving in damages for accidents. Since there will be no crossing of tracks by pedestrians or vehicles in the subway, the damages for accidents on this portion of the route will be largely eliminated.

(*f.*) In addition to the items enumerated, the subway will allow of a greatly increased traffic and a correspondingly increased revenue.

Tending to offset these items are some elements of expense, such, for instance, as the interest on the cost of construction, the maintenance of the structure exclusive of track, the cost of pumping, ventilating and lighting, and the expense of maintaining stations.

THE SUBWAY PLAN APPROVED.

Besides making general studies and investigations with regard to the desirability of the subway, and its relative advantages compared with the other modes of dealing with the transit problem, the Commissioners early initiated detailed studies as to methods of construction, the arrangement of tracks, the traffic which the subway could be expected to accommodate, the proper dimensions to be adopted, the route, number of tracks, entrances, and other details essential to a correct judgment as to the practicability of the subway, and its efficiency as a means of relief for the present congestion.

These studies and investigations led the Commission to the conclusion that the subway presented no insurmountable engineering difficulties, that it could be constructed within the limit of expenditure allowed by the act, that it would render possible a large increase of traffic at a higher rate of speed, that by reason of its capacity for traffic and the economy of railway operations within it, it would reasonably command a rental adequate to meet the interest on its cost and the sinking-fund requirements, and that it was the best method of dealing with the transit problem on the Tremont-street route. The Commission decided, therefore, to make use of the authority conferred upon it by the act, and to proceed with the work of construction.

CONSTRUCTION.

The route provisionally adopted for the subway is shown on the accompanying map. The Columbus-avenue and Boylston-street cars will enter the subway on the Public Garden, opposite Church street, — the Columbus-avenue cars

TREMONT STREET, OPPOSITE PARK-STREET CHURCH, WITHOUT CAR TRACKS.

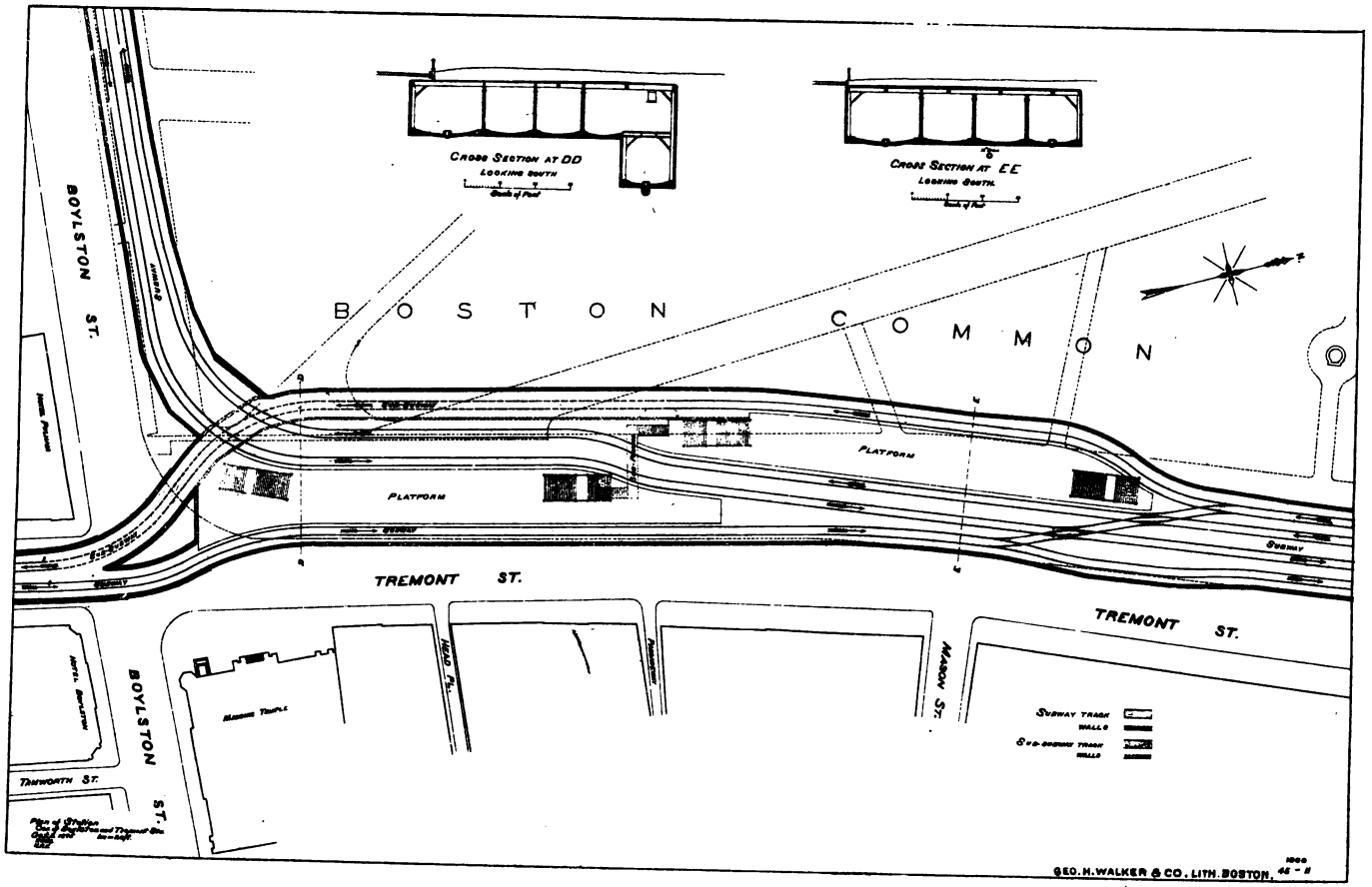


Fig. 1. PLAN OF STATION CORNER OF TREMONT AND BOYLSTON STREETS.

being brought for the purpose over Berkeley street. Two tracks will be carried under Charles street and along Boylston street under the mall of the Common to the corner of Tremont street, where these tracks will be joined by two other tracks leading from the other southern entrance, at the junction of Shawmut avenue and Tremont street. The station at the corner of Boylston and Tremont streets is so designed that there will be no grade crossing of tracks on which cars run in opposite directions, the separation of grades being effected by means of a sub-subway for the south-bound Tremont-street cars, as indicated in Figure 1.

Between Boylston and Park streets the subway will be carried, with four tracks, principally under the mall of the Common, the two tracks on the east being for north-bound cars, and the two tracks on the west for the south- and west-bound cars. At Park street there will be a station, and two tracks will be connected by a loop, around which will pass all cars that do not run beyond this point. It was at first intended to carry this loop in a sub-subway under an intermediate track, but the authority to extend under the Common a short distance beyond the limits of the mall, granted by the Legislature of 1895 (Statutes 1895, chapter 440), rendered it possible to build this loop on the same level with the other tracks. The latter plan has been adopted. (Figures 2 and 3.)

Between Park street and Scollay square two tracks only will be carried under Tremont street. At Scollay square one of these tracks may be carried down Cornhill and the other down Brattle street, while between the two it is proposed to have a loop for cars coming from the north which do not go south of this point. Figure 4 shows a provisional design for the station at Scollay square.

From the foot of Cornhill the proposed route is under Washington street to Haymarket square, and thence, through or under the recently acquired property formerly belonging to the Boston & Maine Railroad, to Causeway street. At this point, which is the northern terminal of the subway, two tracks will be brought to the surface for cars going to Charlestown, Somerville and Cambridge.

The length of the subway from the entrance near the junction of Shawmut avenue and Tremont street to the Union Station will be about one and one-third miles, and the distance from the Boylston-street entrance to the Union Station is about the same. The total length of track in the subway, reckoned as single track, will be about five miles.

There will be four tracks on Tremont street, along the

line of the Common, to take the place of the two existing tracks. It is obvious that each one of these tracks will have a greater capacity than each one of the two present surface tracks, for the reason that the subway tracks will be absolutely free from surface interruptions caused by people and by teams.

The Commission has further enlarged the capacity of each track by avoiding crossings at grade of a track for cars going in one direction by another track for cars going in an opposite direction. The methods of accomplishing this are shown in the arrangement of tracks between Haymarket square and Causeway street and at Park-street station, and more notably at the junction of Boylston and Tremont streets.

The present delays and confusion at the Granary burying-ground are avoided by means of a loop. Each car whose trip ends at Park street, after depositing its passengers, passes by a loop from the inbound to the outbound track, and comes to the platform of the outbound station empty and ready to proceed as soon as the passengers can get aboard. The motorman is not obliged, as now, to change over from one end of the car to the other. All the people who desire to take south-bound cars go to one platform, and all the people who desire to take north-bound cars go to the other platform, and on each side of these platforms there is a track. Take, for example, the platform for south-bound cars. Certain lines of cars will always be found on one side of the platform, and other lines of cars will always be found on the other. The passengers, therefore, will naturally divide themselves according to their destination on the two sides of the platform.

A count was taken on the Saturday before Christmas, 1894, of the number of people taking and leaving the cars at the various stopping-points from West street to the head of Bromfield street. This count was taken for the purpose of determining what should be the capacity of the station platforms, upon which the business of all these stopping-places is to be concentrated. It was found that the total number of people who got on or off the cars within the district named, between the hours of 6 in the morning and 12 at night, was 64,659. Of this, the number who got off from the inward or north-bound cars was 27,851, and the maximum number for any one hour was 3,450, being for the hour from 8 to 9 A.M. The number of persons who got on the outward or south-bound cars, from 6 A.M. to 12 midnight, was 30,027, the maximum number for any one hour being 3,406, for the hour from 5 to 6 P.M. These figures

are interesting, as showing what work the station platforms will be called upon to do. If only one car at a time should be standing at the station platform on each track, and if it were allowed a half-minute for its stop, there would be two cars per minute on each track, or four cars per minute on the two tracks. If each one of these cars should carry off 20 passengers, the total number carried away per minute would be 80, and the total number per hour 4,800, a number 40 per cent. in excess of the great and unusual crowd which thronged the streets on the beautiful Saturday three days before Christmas. If two or three cars, either singly or in train, stop on each side of the station platform at the same time, then its capacity would be doubled or trebled. The platforms at this station are to be about 200 feet in length.

It was decided to begin the construction of the subway along the Common and Public Garden, with a view to completing first the entire part south of Park street. When this portion is completed the cars which do not run north of Park street can be run in the subway. This will relieve Tremont street by the Common from its present congested condition, facilitate the construction north of Park street, and permit an increase of cars whose routes now terminate at the Granary Burial Ground.

Bids for the construction of Section 1, which included all that portion of the subway on Boylston street, and on Tremont street from the corner of Boylston street to West street, with the exception of the station at the corner, were advertised for February 20, 1895, and were opened March 20, 1895. The successful bidders were Jones & Meehan, of this city.

On March 28 the first spadeful of earth was removed, in the Public Garden, by the Chairman of the Commission, in the presence of His Excellency Governor Greenhalge and the members of the Commission, and the work of construction officially begun without further formalities.

Detail plans may be found in the report of the Chief Engineer. Briefly, the method of construction consists of side walls of steel I-beams imbedded in concrete, supporting a roof consisting of transverse steel beams or girders with brick and concrete arches between them. The standard height is 14 feet clear above the top of the rail, the width for two tracks 24 feet, and for four tracks 48 feet. The four-track subway will have a line of steel posts along the centre. The top of the rail will be about 17 feet below the surface of the street, and the station platform about 16 feet. The staircases leading to stations will be covered and enclosed, and the platforms generously proportioned. The platforms

are so-called "island" platforms, that is, they have a track on each side of them, so that all necessity of crossing tracks in the subway is avoided.

The designs prepared contemplate the use, when needed, of fans between the stations to exhaust the air and secure thorough ventilation of the subway. Fresh air will be drawn in at the stations, and will flow in each direction to the ventilating fans, where it will be exhausted through special openings at the side.

The subway will be lighted by electricity, the current for which will be derived from a special plant distinct from that used for motive power and for lighting the cars.

Provision for the drainage of whatever water may find its way into the subway, which, however, will be small in amount, is made by drains laid in the ballast and leading to the lowest points, where pumps will be placed operated by electric motors. The provisions which are to be taken for securing the dryness of the subway consist in the use of a concrete invert or bottom, and in covering the entire top and sides of the subway with a water-proof coating. Special precautions have also been taken, in wet places, to prevent any percolation of water through the walls of the subway.

In comparing this subway with the old tunnels in London with respect to ventilation, it should be remembered that they are in no respect similar as regards the mode of operation. The London tunnels, with the exception of the one recently constructed, are operated by steam locomotives, and are not provided with any artificial means of ventilation. In a recent report of the engineer of the New York Rapid Transit Commission, it is computed that one of the New York elevated railway locomotives vitiates the air as much as 25,000 people, while an ordinary railway engine vitiates the air as much as 87,000 people. In the Mersey tunnel, which is operated by steam locomotives and lighted by gas, but which has artificial ventilation similar to that proposed for the subway, the air is reasonably good. It is evident that it will be easy to secure pure air by artificial ventilation in a subway operated and lighted by electricity.

With regard to temperature the subway will be somewhat cooler in summer and warmer in winter than the outside air. The question of temperature is connected with that of ventilation, and if the air in the subway is frequently changed, the difference in temperature between it and the outside air will be small.

Plans are now nearly completed for Sections 2 and 3 of the work, comprising the stations at the corner of Boylston

and Tremont streets, and at Park street, and it is expected that contracts will be let for these sections before the end of the year.

The Question of connecting the Subway with the Steam Railroads and adapting it for the Use of Steam-Railroad Cars.

Notwithstanding that the act apparently contemplates the use of the subway by street-railway cars alone, the question was early discussed as to whether it was wise to arrange for a connection with the steam railroads so that the cars of these roads could pass directly through the city between the northern and the southern stations.

Conferences were held with officials of the Boston & Maine, and of the New York, New Haven & Hartford Railroads. The result of these conferences was that the Commission received no such encouragement as would justify it in seeking from the Legislature definite power to so construct the subway as to connect it with the steam railroads and adapt it to their use.

The dimensions of the subway are, however, such that it can be used with cars such as are now run by the New York, New Haven & Hartford Railroad in its suburban traffic around New York, the dimensions of said cars being somewhat less than those of the ordinary steam-railroad coach.

Human Remains under the Boylston-Street Mall of the Common.

On the proposed route of the subway there are three burying-grounds; namely, the Common burial-ground, the Granary burial-ground, and the King's Chapel burial-ground.

Originally Boylston street formed the southerly boundary of the Common burial-ground, but in 1836 two rows of tombs were discontinued or closed up, the Boylston-street mall was laid out. and tombs were built on the west side along the line of the mall from Park square to West street to compensate for the tombs which had been closed.

An interesting statement in regard to the laying out of the Boylston-street mall and the closing of the tombs is given in the letter of Samuel F. McCleary, a copy of which will be found in Appendix B.

Anticipating that human remains would be found in making the subway excavations under the Boylston-street mall, the services of Dr. Samuel A. Green, formerly Mayor of the city, and now Librarian of the Massachusetts Historical

Society, were secured on December 1, 1894, to make report as to the proper method to be adopted in removing and reinterring the remains. Dr. Green reported in writing on December 20, 1894. (See Appendix C.)

In excavating on Boylston street human remains were first found on the 18th of April, 1895, and Dr. Green was immediately placed in charge of their disposition. The report of his action, under date of July 27, 1895, will be found in Appendix D.

As stated in Dr. Green's report, reinterments were made in the adjoining burial-ground on the Common, with the exception of the contents of the Lowell and the Tuttle tombs, which, at the request of members of the respective families, were buried elsewhere.

The locality of the reinterments will be marked by a slate tablet, and three small stones will designate the limits of the plot. On the tablet will be this inscription:

HERE WERE REINTERRED
THE REMAINS OF PERSONS
FOUND UNDER THE BOYLSTON STREET MALL
DURING THE DIGGING OF THE SUBWAY.
1895.

The bones were so scattered that it was impossible to determine the exact number of bodies. The estimate made is that the bones of 910 persons were reinterred.

A statement of the inscriptions on the tombs and coffins, so far as legible, will be found in Appendix E.

REGRADING PARTS OF THE COMMON AND PUBLIC GARDEN.

The importance of raising the grades of portions of the Common and of the Public Garden adjacent to Charles street, for both sanitary and esthetic reasons, has long been apparent, but no systematic attempt has been made heretofore to carry out such improvements, in view, probably, of the large cost of the filling required.

While new parks were being created upon a vast scale, and under the best professional and scientific direction, portions of the oldest of the city's pleasure-grounds were allowed to remain unimproved.

In making plans and estimates for the construction of the subway, the engineers found that the earth to be removed

could be used economically in raising the grades of the unsightly and badly drained area of the Common, known as the "parade ground," and of the low portions of the Public Garden, near Charles street, and that they could thus be put into condition more in keeping with the other parts of the grounds, at a minimum expense and with a saving in the cost of the subway. His Honor the Mayor approved of the scheme and directed that Messrs. Olmsted, Olmsted & Eliot, landscape architects, should be asked to make plans for these improvements, to be submitted to him for his approval.

After a study of the conditions, Messrs. Olmsted, Olmsted & Eliot completed plans which received the approval of His Honor, who ordered that the work should be done at the expense of the Commission and under the direction of the Superintendent of Public Grounds, which instructions, so far as the work has progressed, have been followed.

The regrading of the Public Garden, including the removal and replanting of trees and shrubs, has been nearly completed, while that of the Common has been only begun. The amount of material required for the work will approximate 9,000 cubic yards for the Public Garden and 62,000 cubic yards for the Common.

When this latter part is finished there will no longer be any excuse for misusing that part of the Common as a winter dump for snow and ice, mixed with street filth, which heretofore has made the place offensive and malodorous, if not actually injurious to the health of citizens. On the contrary, the Common will correspond in its grassy slopes, in summer, and varied contours, in winter, with the other portions of Boston's most ancient and valued public domain.

The Commission is confident that citizens will soon recognize in these substantial improvements, which will permanently add to the beauty and salubrity of the Common and Public Garden, some compensations for the sacrifices they have made in having the subway built under the Boylston and Tremont street malls.

Injunction Proceedings.

The Commission had incurred or contracted liabilities amounting to about $1,000,000 when it was served with notice by subpœna, on April 24, 1895, that a bill in equity had been filed on April 22 by Frederick O. Prince *et als.* against George G. Crocker and the other Commissioners, the City of Boston and Jones & Meehan, praying that a preliminary injunction might issue forthwith,

enjoining the defendants against further prosecution of the work.

The bill was returnable the first Monday of June in the Supreme Judicial Court. The Commission retained Messrs. Solomon Lincoln and Francis W. Kittredge to appear for it. Counsel for the plaintiff desired an immediate hearing on the motion for an injunction. This request for an immediate hearing the Commission did not oppose, and a hearing was had before Mr. Justice Holmes. The counsel for the city of Boston were not prepared to proceed. The presiding Justice declined to grant an injunction at this time, and the case was set down for hearing on the return day of the writ, June 4.

On that day the plaintiffs discontinued as to Jones & Meehan, and also made a motion to dismiss as to Alfred T. Turner, treasurer of the city of Boston. The motion was allowed, and the motion for the injunction was argued by counsel.

The contention of the plaintiff was substantially:

First. That the Commissioners had exceeded the authority given by the act by beginning work on the Public Garden, and had no right under the act to occupy any part of the Public Garden, and could not go under Charles street.

Secondly. That the act was unconstitutional as being an infringement of the right of local self-government.

After a hearing, occupying two days, the presiding Judge, Mr. Justice Knowlton, decided against the plaintiffs on the points raised and argued; and on July 5 denied the motion for a preliminary injunction, rendering the following opinion:

This case presents some very interesting legal questions, but I am glad to say that the consideration of them leaves me free from any embarrassment in the performance of my duty. The counsel for the respondents, at the outset, has raised objections on several grounds to the position taken by the plaintiffs, and to their standing in court to prosecute a suit of this kind. I have no occasion to pass upon any of those questions, although some of them are certainly interesting. The first inquiry which the Court has to make, in dealing with this petition, is whether it is shown that the defendants now before the Court have exceeded the authority which the statute purports to give them. It was contended by the plaintiffs, first, that the statute gives them no authority to construct any part of this subway in the Public Garden, and, secondly, that the statute gives them no authority to construct any part of this subway in any place which is not either under or adjacent to a street. At one stage of the hearing, before I quite understood what had been done in the Public Garden and appreciated the nature of the work there, I was in doubt whether the defendants had not gone beyond the authority conferred by the act. I feel quite clear that they have no power to do anything on the Common or in the Public Garden except what is given them by the act itself, expressly or by very clear

implication, and that part of the act which authorizes the construction of a subway from Tremont street through and under Boylston street and the adjoining mall of Boston Common or other public or private lands adjoining said street gives them authority to go no farther than through the mall, which would terminate at Charles street, except as authority is contained in these words: "Or other public or private lands adjoining said street, to a point on or near Boylston street, where a suitable connection with surface tracks may be made." It seems to me that they have authority to go just so far beyond the point definitely stated as the mall of Boston Common as is reasonably necessary to make a suitable connection with the surface tracks in Boylston street, and the Court cannot say, upon the evidence now before the Court, that, in carrying this subway the distance of about four hundred feet into the Public Garden for the purpose of making connection with the tracks beyond Boylston street, they have gone farther than is reasonably necessary to make a suitable connection with the tracks. Of course, it would be necessary to make a grade which would not be too steep, and for that purpose to extend the subway a certain distance beyond the point where it was entirely beneath the surface, and, so far as appears, this distance is not more than is reasonably necessary. Whether it could have been shortened a few feet or not, I cannot undertake to say, but it is enough to say that it does not appear that it could. Then, as to that part of the petition that the subway in the Garden is not adjacent to the street, I do not interpret the statute as meaning that the subway itself must necessarily be either under Boylston street or exactly adjacent to it, so that the line of the subway shall correspond with the bound of the street, but it is enough if they go to such a place as is reasonably necessary to make a suitable connection with the surface tracks and go through private lands or public lands which are adjoining the street. The land through which they must go must be lands adjoining the street, and the Public Garden is land adjoining the street, and the short distance between the tracks and Boylston street, chosen, I suppose, on the grounds of convenience, does not appear to me as being in conflict with the provisions of the statute. I therefore am very clear in saying that it does not appear that the Commissioners have gone beyond the authority which the statute gives, either expressly or by clear implication.

The remaining question is whether the statute is unconstitutional. Of course, everybody familiar with proceedings in court appreciates that the Court would hesitate, unless a very strong case were made out, to interfere with the operation of a statute, while sitting as a single Justice, on constitutional grounds, and at the same time, as I said yesterday to Mr. Lincoln, I can conceive of a case where the constitutionality of the statute would seem to be so very doubtful or so improbable that it might be the duty of the Court to interrupt a proceeding which might cause great public injury, long enough to have the question of constitutionality passed upon. I therefore have heard the argument of counsel upon this question. In the first place, it is said that there is a tripartite contract and that it would be unconstitutional to attempt to do anything to the Public Garden on the land which is covered by that contract; but it appears and is conceded that the work which is going on is not upon any part of that land, and I do not see, therefore, how the Court has occasion to consider any further the effect of the tripartite contract. It might be argued with a good deal of force that the sovereign power at the State House could, in a matter of this sort even, for public uses, take land which was covered by that contract. It is not necessary to consider that question.

It is said that this statute, as it is being interpreted by the Commissioners, and perhaps as it is necessary to interpret it, conflicts with many other provisions of law, the general law which forbids the use of

a park for railroading except by vote of the city or town, the law which gives jurisdiction to the mayor and aldermen in regard to matters of this kind, the law forbidding certain erections upon the Common, and the law which places the public grounds, the Common and Public Garden in charge of a city authority, and sundry provisions of the statute. That is certainly so, but it must be said at the same time that this statute, just so far as it comes in conflict with any other provisions of the statutes (it may be either in special acts or in general laws), must be deemed to be a repeal of those provisions of the statutes so far as they apply to the subject-matter of this act, and I am justified in saying that the true construction of the statute requires us to say that those statutes are superseded for the purposes of this act by the statute now being considered.

We have, then, a very grave and interesting and important constitutional question which relates to the subject of local self-government. I don't find in this act, important as it is, anything which seems to me to be different in principle from other acts, the constitutionality of which has been established by courts of last resort. There is the Metropolitan Police bill in the State of New York, which has taken out of the hands of the citizens of New York city control of a very important department of their government and placed it in the hands of the central authority at Albany. Our own Police Commission in this city, which is similar in character as to its origin, stands upon the same ground, has connected with it the same questions. All those were very fully considered in the case of Commonwealth *v.* Plaisted, and kindred questions have been considered by this Court at other times. The substance of that act, which was upheld by this Court, is a taking by the Legislature from the hands of the city of Boston of part of the management of all the affairs of its police and putting them in the hands of a commission appointed by the Governor, which commission has a right to do that which calls for the expenditure every year of hundreds of thousands of dollars on the part of the city of Boston, and it was argued with a good deal of force that that was an important interference with the principle of local self-government; but the Court held that it might be done, as the Court of Appeals had previously held in the State of New York that a similar statute there was constitutional. Now, here, the Legislature has put into the hands of a commission, two of the members of which are appointed by the Governor, others of which are appointed by the Mayor, the management of a very important part of public business of the city of Boston, — that part which relates to public travel; not all the public travel of the city of Boston, but a greater part. Of course, if this statute can stand, the Legislature might put in the hands of a commission the control of the streets, so far as construction and arrangement for public travel is concerned, in every part of the city of Boston. The act was submitted by its provisions to the citizens of Boston for their approval, and has been approved by them. I must say that, in view of the decisions which have previously been made, I cannot help feeling that this statute is within the constitutional authority of the Legislature, that it is a modification of the charter of the city of Boston in a very important particular, and at the same time that it is a modification which the sovereign power can make. What would be the effect if the charter of the city of Boston were repealed altogether, — as Mr. Brooks concedes that the Legislature might repeal it, — it is not necessary to determine. His argument is that then there would be absolute power, so far as local affairs are concerned, in the citizens residing here, under the old system of town government. Whether the Legislature could undertake, could successfully undertake, to abolish town government in Massachusetts, is a very different question from what it would be whether, after a

charter has been granted to the citizens of Boston and has been accepted and approved by them, material alteration in the charter can be made which does interfere very greatly with local self-government. But it is enough to say that, upon this fundamental, most important question in the case, as I think, I cannot help feeling that the plaintiffs here fail to make out the position which they assume to establish, — that this act is unconstitutional.

There is another ground on which it has been expressly attacked, and that is that the use for which these lands on the Garden and the Common are being taken is not a public use, and so that the Legislature had no authority to interfere in that way. Of course, if my view is correct as to the general position, that the Legislature may, with the consent of the citizens of Boston, take into its hands the whole business of constructing streets in the city of Boston, and sewers in the city of Boston, this question, perhaps, would be merely incidental and not so important; but it seems to me manifest, I confess, and when you apply it to the well-known condition of public travel in the city of Boston, that this use is a public one, and whether it is the wisest and best mode of dealing with a public question, this Court has no occasion to consider. It is a mode which the Legislature has chosen to adopt of dealing with a public question which has agitated, not only the citizens of Boston itself, but a large part of the public who are interested in the transportation of people in the city; and it is as clear to me as anything can be that this is an attempt on the part of the Legislature, and a decision on the part of the Legislature, to take these lands and appropriate them to a public use, and the Court cannot interfere with their position upon that question.

So, as I said at the outset, while the Court would hesitate to act in a case of this kind unless unconstitutionality seemed pretty clearly made out, my mind leaves me free from any embarrassment. I do not think the act is unconstitutional. I think quite decidedly that it is within the constitutional power of the Legislature. And therefore this motion for a preliminary injunction is denied.

From the time when injunction proceedings were initiated up to the time when Mr. Justice Knowlton rendered his decision no new work was entered upon. On the 12th of July the City of Boston appeared, and, on motion of counsel, was made a party to the bill.

The bill is still pending. In the meantime counsel for respondents have filed a demurrer denying the right of the plaintiffs to bring the bill. Several amendments to the bill have been made by the plaintiffs, and permission has been been given to file them. The Court has given the respondents until September 6 to file a demurrer or answer to the amended bill.

Such is the status of the proceedings in court.

LEGISLATION OF 1895.

The Commission was convinced, as soon as it had formed its general plan and received the estimate of cost, that, if the subway contemplated in the act was to be built economically and efficiently, certain amendments should be made to the law under which the Commission was acting.

No settlement of the damages for any of these estates has yet been made.

THE CHARLESTOWN BRIDGE.

By Statutes of 1894, chapter 548, section 30, the Commission is required to construct a bridge over Charles river, having regard to its use for railway purposes, between the present Charles-river bridge and Fitchburg-railroad bridge.

Soon after the organization of the Commission, Mr. William Jackson, the City Engineer, was requested to make studies requisite for the determination of the best location and method of construction of the bridge.

The first plans were submitted by Mr. Jackson on October 9, and since that time a large number of studies and designs has been under consideration. During the autumn and winter, statistics of travel, of tonnage, etc., across the river and up and down the river and on the streets adjacent to the river, were collected. The purpose of these statistics was to determine the extent and nature of the traffic to be accommodated by the bridge, its proper location, its height and grades.

Another important question to which much attention was given was whether the bridge should be built without a draw. Several hearings were given to the Charlestown Improvement Association and numerous interested parties, and conferences were held with the Harbor and Land Commission and with officials of the cities and towns interested. The weight of opinion and argument favored the construction of a drawless bridge of a clear height at the central spans of about twenty-three feet. The cities of Cambridge, Somerville, and Chelsea, by vote of their city councils, and the town of Revere, by vote of its selectmen, took action in favor of a drawless bridge.

The Commission was satisfied that a drawless bridge was desirable, but it found that State legislation, and also permission from the United States, was a necessary preliminary. The Commission was further advised by its engineer that the question whether the bridge was to be built with or without a draw must be determined before the construction of the bridge was begun. Application was early made to the Legislature for the necessary State legislation, and two members of the Commission, accompanied by the Corporation Counsel and the City Engineer, went to Washington to confer with the Secretary of War and other authorities.

After several months it was demonstrated that it would take two or three years to obtain the permits requisite for a

drawless bridge, and the Commission therefore abandoned the plan, being convinced that it would be unwise to delay the work so long without any assurance of success.

The determination of the location of the bridge was complicated by the fact that there were before the Legislature several bills for the widening of streets in the city proper at the North End, which, if acted upon favorably, might have an important bearing on the question. It was deemed unwise to fix the location of the bridge while these bills were pending. Just at the end of the session one of these bills became a law, and by it the Street Commissioners were authorized to lay out a new avenue across the city at the North End on the line of Cross street, and also to widen Charlestown street to Causeway street.

Owing to a lack of funds the Street Commissioners do not intend to widen Charlestown street at the present time, but, in harmony with the spirit of the act referred to, the Boston Transit Commission has fixed the location of the Charlestown bridge so that Charlestown street when widened shall be an appropriate approach thereto. (See plan.)

It is proposed to have the bridge roadway about 100 feet in width, and to have the clear height of the draw not less than 17 nor more than 23 feet above mean high water, so that a considerable portion of the traffic on the river can pass up and down without requiring the opening of the draw.

The Charlestown terminal will be at City square, from which point the grade will rise so as to pass over Water street and the tracks of the Fitchburg railroad. On the Boston side the bridge will come to grade at Causeway street opposite Charlestown and Endicott streets, the roadway being widened so as to connect with Causeway street in either direction by easy curves. When Charlestown street is widened in the future, the greater width of the bridge as it approaches Causeway street will render it possible to carry the central portion over Causeway street on an elevated structure coming to grade on Charlestown street somewhere between Causeway street and Haymarket square.

The location and the general character of the bridge having been determined, the City Engineer was forthwith authorized to prepare detail plans for its construction.

EAST BOSTON TUNNEL.

June 27, 1895, the Common Council of the city of Boston passed an order requesting the Commission to report at the next meeting of the Council the probable cost of construct-

ing a suitable tunnel to East Boston, as authorized by chapter 548, section 26, Acts of 1894.

The Chief Engineer of the Commission is now engaged in making such an estimate, and borings and soundings therefor have been under way since the reception of the request by the Commission.

ISSUE OF BONDS.

Under section 37, chapter 548, Acts of 1894, the Commission has called for bonds to the amount of $1,060,000. Of this sum $50,000 was issued in November, 1894, for purposes of the subway, and $10,000 in January, 1895, for the Charlestown bridge, both amounts being taken by the Sinking-Fund Commissioners. April 1, 1895, the City Treasurer negotiated, at the request of the Commission, a loan of $1,000,000, of which $750,000 was for payment for the property taken from the Boston & Maine Railroad and the balance for construction. These bonds were sold at a premium of $13.91, said premium amounting to $139,100, which, under section 38 of the same chapter, has been paid into the Sinking-Fund for the extinguishment of the debt.

ROOMS OF THE COMMISSION.

The offices of the Commission were at No. 60 State street, in the old Suffolk Bank building, from October 1, 1894, until August 1, 1895, when a removal was rendered necessary by the transfer of ownership of the Suffolk Bank building and preparations for its destruction. New quarters were secured in the Claflin building, No. 20 Beacon street, where two floors are occupied by the Commission, its executive officers, and the engineering department.

STATISTICS.

In the prosecution of its work the Commission has gathered statistics of many kinds. Some of these, being of value for future reference, are preserved in this report, and will be found in Appendix F.

They relate to the following matters:

	Table.
Grades of streets (furnished by City Engineer Jackson)	1
Width of streets and sidewalks (Street Commissioners)	2
Travel over and under bridges (Superintendent of Streets Carter)	3 & 4

Acknowledgments.

The Commission desires to make this public acknowledgment of its obligations to many gentlemen for information or advice:

To His Excellency Governor Greenhalge, and His Honor Mayor Curtis, for official coöperation.

To Honorable Nathan Matthews, Jr., ex-Mayor of Boston. From the date of his first message to the City Council recommending the acceptance of the Subway Act of 1893 up to the present time he has manifested a warm interest in the success of the project, and has frequently aided the Commission by valuable counsel and advice.

To Vice-President and General Manager F. K. Hain, of the Manhattan Railway Company, of New York, for information with regard to the amount of traffic handled and the dimensions of station platforms and stairways of elevated railroads in New York.

To the officials of the Boston & Maine, Fitchburg, and New York, New Haven, & Hartford railroads, for statistics of travel bearing upon the amount of traffic to be provided for by the subway.

To the Boston & Maine and Fitchburg railroads, for aiding the Commission in the solution of the problems connected with the proposed bridge to Charlestown.

To the officials of the West End Street Railway, for information concerning the number, routes, and movements of its cars, the number of passengers carried thereon, etc.

To the officials of the Lynn & Boston Railroad, for similar courtesies.

To various engineers for advice, information, and coöperation in connection with the subway work; among these may be specially mentioned:

William Barclay Parsons, Chief Engineer, New York Rapid Transit Commission; T. C. Clarke, of New York; Joseph P. Davis, Chief Engineer of the American Bell Telephone Co., of Boston; F. von Emperger, of New York; L. B. Bidwell, Chief Engineer of the New England Railroad; H. Bissell, Chief Engineer of the Boston & Maine Railroad; I. H. Farnham, of Boston; Walter Katte, Chief Engineer of the New York Central & Hudson River Railroad.

To Henry Lee, Thomas L. Livermore, Charles S. Sargent and George B. Upham, for assistance in devising means for reducing, so far as possible, the destruction of trees on the common, and for advice as to the best treatment of those trees which stand so near the subway lines as to be possibly affected by the work.

To Samuel F. McCleary, ex-City Clerk, and Benjamin F. Smith, for information relating to the tombs in the abandoned portion of the Central burying-ground, and advice as to the best treatment for such remains as might be found therein.

To Simpson & Wilson, Engineers, Glasgow, Scotland, for details of the subway now building in that city.

To the officials of the Baltimore & Ohio Railroad for courtesies extended in the inspection of its tunnel in Baltimore.

To General A. P. Rockwell, for information and official documents relating to the building of the subway for the Chemin de Fer de Sceaux, in Paris.

To Philip L. Saltonstall and Walter H. Knight, of the General Electric Company, for suggestions in regard to trolleys and trolley arms, which were of benefit in determining the height of the subway.

To John R. Murphy, Commissioner of Wires, for information as to the cost of placing electric wires in conduits and as to the amount of space which might be required for the same.

To Andrew J. Bailey, Corporation Counsel, and Thomas M. Babson, City Solicitor, for advice on legal points.

To Edmund M. Wheelwright, ex-City Architect, for sketches and suggestions both for the subway and for the bridge.

To Clinton White, Lamont G. Burnham, the Board of Street Commissioners, and His Honor Mayor Brancroft, of Cambridge, for information and counsel relating to the proposed bridge to Charlestown.

STATEMENT OF EXPENSES.

The following is a classified statement of the expenses of the Commission, approved to Thursday, August 15, 1895:

SUBWAY.

Subway Commission — General Expenses incurred under chap. 478, Acts of 1893	$4,307 42	
Subway Commission — but approved by Transit Commission	2,323 74	
Subway Commissioners (salary voted by City Council)	7,500 00	
Total		$14,131 16
Boston Transit Commission — General Expenses:		
Office — Repairs	$753 57	
Furniture	1,282 38	
Supplies	784 45	
Stationery and printing	519 62	
Fuel and light (1–2)	191 51	
Rental (1–2)	750 00	
Stenographer	571 50	
Messenger	516 00	
Janitor (1–2)	181 35	
Salaries of Commissioners and Secretary	28,334 66	
Total	$33,885 04	
General Expenses: 4–5 to Subway		27,108 03

ENGINEERING DEPARTMENT.

Rooms — Repairs	$396 42	
Furniture	700 21	
Supplies	1,793 38	
Stationery and printing	983 16	
Fuel and light (1–2), and heat,	241 13	
Rental (1–2)	750 00	
Janitor (1–2)	181 35	
Total		5,045 65
Legal and professional advice	$6,827 00	
Messenger	15 83	
Stenographer	667 00	
Instruments	661 59	
Supplies	1,920 02	
Advertising	244 03	
Labor	4,816 25	
Counting travel	1,343 89	
Repairs for borings, foundations, etc.	752 33	
H. A. Carson, Chief Engineer	5,733 00	
Skilled service	19,167 88	
Total		42,148 82
Carried forward		$88,433 66

Brought forward		$88,433 66
Land damages — Haymarket square property,	$750,000 00	
Insurance	407 50	
Custodians	544 83	
Watchman	157 29	
Labor	4 00	
Miscellaneous	40 89	
Total		751,154 51

SECTION ONE (UNDER CONTRACT).

Jones & Meehan	$41,678 62	
Pennsylvania Steel Co.	19,128 56	
Department of Public Grounds	2,533 63	
Legal and professional advice	100 00	
Teaming	1,211 00	
Loam and fertilizer	55 74	
Sod	45 00	
Furniture	48 55	
Office supplies	240 60	
Field supplies	968 15	
Printing	166 67	
Fuel and light	2 20	
Rental	95 83	
Advertising	680 77	
Care of human remains	202 00	
Total		67,157 32

SECTION TWO (STATION AT BOYLSTON AND TREMONT STREETS).

Department of Public Grounds	$429 68	
Loam	59 00	
Office supplies	1 68	
Field supplies	14 78	
Skilled service	150 00	
Labor	61 83	
Total		716 97

SECTION FOUR (FROM SECTION TWO TO SHAWMUT AVENUE AND TREMONT STREET).

Office supplies	$4 53	
Field supplies	132 78	
Labor	1,206 22	
Total		1,343 53

EAST BOSTON TUNNEL.

Field supplies	$14 03	
Labor	179 28	
Total		193 31
		$908,999 30

CHARLESTOWN BRIDGE.

General Expenses: 1–5 to Bridge	$6,777 01	
Stenographer	37 50	
Stationery and printing	17 75	
Supplies	507 98	
Advertising	55 83	
Counting travel	100 75	
Skilled service	759 28	
Total		$8,256 10

SUMMARY.

Subway. — Subway Commission	$14,131 16	
4–5 General Expenses	27,108 03	
Engineering Expenses (office)	5,045 65	
" " (general)	42,148 82	
Haymarket-sq. Property	751,154 51	
Section One	67,157 32	
Two	716 97	
Four	1,343 53	
East Boston Tunnel	193 31	
Total		$908,999 30
Bridge. — 1–5 General Expenses	$6,777 01	
Engineering Expenses	1,479 09	
Total		8,256 10
Total		$917,255 40

The report of the Chief Engineer is appended.

GEORGE G. CROCKER,
CHARLES H. DALTON,
THOMAS J. GARGAN,
GEORGE F. SWAIN,
ALBERT C. BURRAGE,
Boston Transit Commission.

BOSTON, August 15, 1895.

GEORGE G. CROCKER, CHARLES H. DALTON, THOMAS J. GARGAN, GEORGE F. SWAIN, ALBERT C. BURRAGE, *Boston Transit Commissioners:*

GENTLEMEN: The Engineering Department was organized in the early part of September, 1894.

On account of hard times, the completion of extensive works in this vicinity, and the cessation of operations on others, it was comparatively easy to find an excellent corps of assistants. The names of some of them are subjoined, and an indication is given of a portion of the work on which they have been engaged.

OFFICE ASSISTANTS, August 15, 1895.

Assistant Engineers (names in alphabetical order).

EDMUND S. DAVIS. General oversight of field, and miscellaneous office-work.
F. B. EDWARDS. Lines, grades and estimates on construction.
GUY C. EMERSON. Inspection of construction.
JOHN P. HILL. Designs and studies for stations.
H. J. HOWE. Preliminary surveys.
WM. W. LEWIS. Miscellaneous studies, and office engineering work.
PATRICK F. O'BRIEN. Preliminary surveys and studies for stations.
*CHARLES H. SWAN. Designs for changes in sewers and pipes.
A. N. WAHLBERG. Studies for locations and designs of subways.
*JOSEPH R. WORCESTER. Designs for steel-work.
E. E. YOUNG. Miscellaneous studies.

Draughtsmen, Transitmen, etc.

CHAUNCY R. PERRY, Draughtsman.
JOSEPH A. ROURKE, Draughtsman.
W. F. MANN, Draughtsman.
HENRY R. KIMBALL, Draughtsman.
LEONARD H. DAVIS, Transitman and Draughtsman.
J. CALVIN LOCKE, Transitman and Draughtsman.
ROBERT B. FARWELL, Transitman.

* Works only a part of his time for the Transit Commission.

*NELSON A. HALLETT, Cement tester.
ARTHUR B. CARTER, Clerk and Stenographer. Correspondence, checked bills, collected and compiled data.
A. W. TREFRY, Plan-keeper.
*GEORGE P. GOODMAN, Photographer.

CONSULTATIONS, ETC.

The City Engineer, and other city officials, have been consulted in regard to details concerning their respective departments. The following gentlemen have been consulted, as indicated:

H. H. CARTER, C.E. (Appointed Consulting Engineer by the Commission.) Live loads over subway. Durability of steel. Cross-sections. Estimates of cost. Grade of subway in reference to surface of streets. Specifications, etc.
JOHN E. CHENEY, Asst. City Engineer. Cross-sections. Strength of different members.
PROF. S. HOMER WOODBRIDGE. Ventilation.
C. S. SERGEANT, Gen. Manager of the West End Street Railway Co. Stations, arrangement of tracks, etc.
A. L. PLIMPTON, Chief Engineer of the West End Street Railway Co. Stations, arrangement of tracks, etc.
PAUL WINSOR, Asst. Gen. Manager of the West End Street Railway Co. Necessary height of subway, etc.
MORRIS HOOPES, Electrical Engineer of Lynn & Boston Railroad. Necessary height of subway, etc.

Advice and suggestions have also been received from:

THOMAS C. CLARKE, C.E.
H. BISSELL, Chief Engineer of the Boston & Maine Railroad.
L. B. BIDWELL, Chief Engineer of the New York & New England Railroad.
F. S. PEARSON, C.E.
G. M. TOMPSON, C.E.
GEORGE S. MORISON, C.E.
JOSEPH P. DAVIS, C.E.
And others.

PRELIMINARY WORK, DATA, ETC.

During the month of September the Chief Engineer gave, on account of previous engagements, but a comparatively small proportion of his time to the work of the Transit Commission. In succeeding months this proportion was constantly increased. He visited Europe during March, April,

* Works only a part of his time for the Transit Commission.

and May, partly for personal reasons and partly to study various details relating to the work of the subway. Engineers were interviewed and engineering objects of interest were visited in Italy, Austria, Hungary, Germany, France, and Great Britain. Some of the allusions and references contained in the following pages were suggested by these interviews and observations. During his absence Mr. Edmund S. Davis acted as Chief Engineer.

The first work of the Engineering Department was to collect and arrange the engineering information bearing on the subject of the subway which had been gathered by preceding commissions.

A case (originally deposited by the Rapid Transit Commission) was obtained from the State House, containing sketches for elevated railways, lithographed maps on which routes had been indicated, tracings, three field note books of original surveys, etc. These sketches and plans are mostly for territory outside of the district fixed upon for the subway. Forty-four sheets, tracings, sketches, and diagrams, were received from the Subway Commission, indicating proposed routes, studies for stations, etc. All of these were indexed and filed.

Most of the subway route will necessarily lie along narrow streets which are nearly filled with street railways, gas-pipes, water-pipes, electric conduits, sewers, etc. The subway construction will extend deeper than the foundations of most of the buildings which lie along its side. Injury to these structures would necessarily entail a great loss, and the subway should be so planned and built as to avoid such injury. It is obvious that intelligent and economical designs must necessarily be based upon exact information as to the position of these pipes, sewers, buildings, etc. This needed information has been obtained by original surveys and by examinations and compilations, some account of which is given in the following pages. Careful examination has been made of what has been done by others, so as to avoid unnecessary duplication of work.

Search was made in the various City Departments, and in the offices of the various gas, electric, and other companies, for plans giving locations of their pipes, conduits, etc.

The officers of the city departments and of the companies have aided in facilitating this search. The records of most of the underground pipes, sewers, and other structures laid years ago were very imperfectly kept, in fact many such structures were built without any record of their location being made. The plans obtained were usually on scales less than fifty feet to the inch, many of them on a scale as small as one hundred feet to the inch. They, however, have been useful in showing the approximate positions of the

structures, and all that were available have been copied. Several large maps on a scale of twenty feet to the inch were received from the City Engineer's office, on which the base lines had been carefully measured and a considerable number of points, such as street corners, accurately plotted. Extensive sub-surface surveys have been made which are referred to elsewhere in this report.

SURVEYS AND PLANS.

This department has about twenty note books containing notes of its original surveys, and has made about six hundred and fifty plans, most of which are based on these notes.

The notes of the surveys of the streets have been plotted, on a scale of twenty feet to the inch, on large rolled plans, and some of the most important on scales as large as eight feet to the inch.

Surface Surveys and Plans. — Surface surveys have included:

Tremont street, from Scollay square to Castle street.
Boylston street, from Tremont street to Berkeley street.
Columbus avenue, from Boylston street to Berkeley street.
Pleasant street, from Carver street to Shawmut avenue.
Carver street.
Eliot street, from Tremont street to Park square.
Sudbury street.
Brattle street.
Cornhill.
Court street, from Washington street to Sudbury street.
Hanover street, from Court street to Union street.
Union street, from Haymarket square to Hanover street.
Washington street, from Court street to Haymarket square.
Merrimac street, from Haymarket square to Portland street.
Market street.
Travers street, from Portland street to Beverly street.
Causeway street, from Portland street to Beverly street.
Beverly street, from Causeway street to Haymarket square.
Haverhill street.
Canal street.
Friend street, from Causeway street to Washington street.
Portland street.

Base lines have been run and the building lines and sidewalks located in the following streets:

Park street.
Mt. Vernon street, from Beacon street to Temple street.
Temple street.
Bowdoin street.
Green street, from Bowdoin square to Staniford street.
Cambridge street, from Bowdoin square to Hancock street.
Staniford street.
Norman street.
Hawkins street.
Chardon street, from Bowdoin square to Hawkins street.
South Margin street.
Pitts street.
Crescent place.

Measurements were taken of all building fronts and locations were made of manholes, sidewalks, lamp and electric posts, street-car tracks, and all other surface objects on streets along proposed subway routes from near the junction of Tremont street and Shawmut avenue, through Tremont street, Cornhill, Brattle street and New Washington, Canal, and Haverhlll streets to Causeway street; also in Boylston street, from Berkeley street to Tremont street, and on Columbus avenue, from Berkeley street to Boylston street.

Surveys and plans have been made showing the location of trees in or near the Boylston and Tremont street malls of the Common. Topographical surveys and plans have been made of the western portion of the Common and the southern portion of the Public Garden, showing the contours, locations of trees, etc., on the areas which the Commission proposes to regrade by depositing thereon the surplus earth from the subway.

Sub-Surface Surveys. — Sixty-seven borings (in addition to the eighteen made by the Subway Commission) have been made to determine the character of the ground and the difficulties to be overcome in excavating for the subway. They have varied in depth from 25 to 50 feet, and have been made at various points in the territory bounded by Berkeley street and by Pleasant street on the south and by Causeway street on the north. The results obtained have been plotted on profiles showing the character of the ground along the proposed route.

Excavations have been made (mostly in the cellars and basements) to the bottom of the foundations of buildings. Levels of the bottom of the foundations have been taken, the thickness of the walls measured, etc. Excavations were made in this manner on Tremont street, from Warrenton street to Boylston street, and from Winter street to Scollay square; also through Cornhill, Brattle street, Sudbury street, and Washington street from Cornhill to Haymarket square.

In order to more accurately locate the pipes, sewers, etc., in the streets, further excavations have been made across the streets at many places along the line, and others are now being made. Cross-sections of the streets have been plotted, showing the location of the pipes, the areas under the sidewalks, the building fronts and foundations. In some cases where it would have been difficult to avoid interruptions to travel if the excavations had been made by open trench, small tunnels have been run across the street, and from these tunnels the various structures were located.

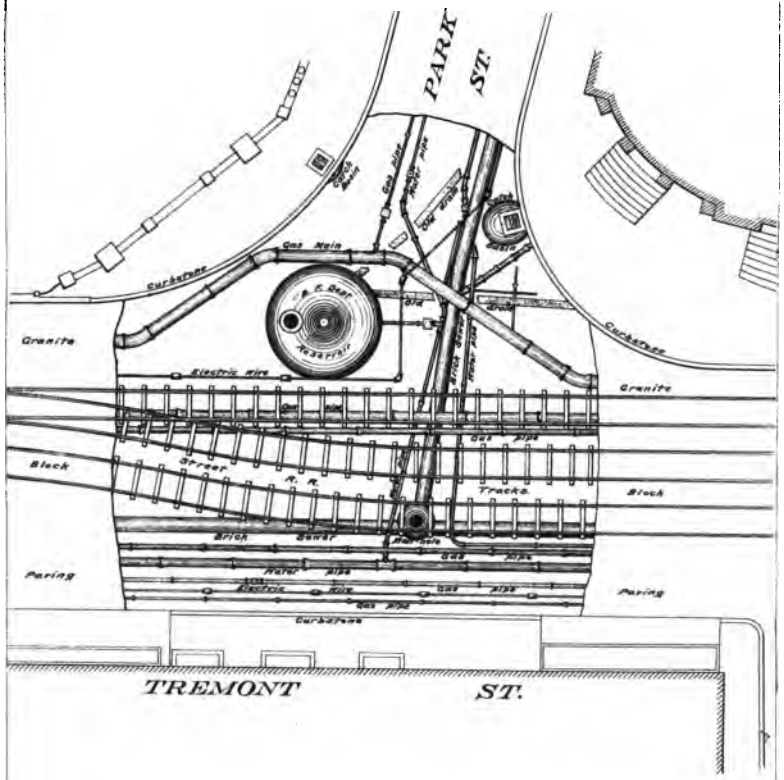
A cut on an adjoining page will serve as an illustration of the network of underground objects found in the streets to be traversed by the subway.

Excavation is now progressing in Tremont street, near Eliot street, to see what difficulties, in the way of fine sand and water, exist in that locality. This trench will be further utilized by building therein a small portion of the masonry of the subway.

Pipes and Sewers. — Numerous studies have been made for relaying water-pipes, gas-pipes, electric conduits, and sewers, which may be interfered with by the construction of the subway. Estimates of cost for such new locations have also been made.

Miscellaneous Studies. — A set of twenty-three maps has been made showing the routes of all the lines of street cars that run through those streets, or portions of streets, under which the subway is to be built. There are seventy-one different lines of cars run by the West End Street Railway Company and five lines run by the Lynn & Boston Railroad, making a total of seventy-six distinct lines of cars passing through the streets that are included in the subway district.

These seventy-six lines were divided into twenty-three groups in such a way that each group comprised those lines of cars having identical routes through the subway district, or having the same terminus within the limits of the district.



TREMONT STREET AT PARK STREET (AN ILLUSTRATION OF THE NETWORK OF UNDERGROUND OBJECTS TO BE MET IN CONSTRUCTING THE SUBWAY.)

GEO. H. WALKER & CO. LITH., BOSTON

The routes of these twenty-three groups were each shown on a separate map, and on each map a table was printed giving the names of the different lines of cars in each group, the maximum number of cars per hour and the total number per day.

A set of twenty-nine plans was made showing the number and exact location at intervals of two and one-half minutes, of the cars on Tremont and Boylston streets, from 4.50 to 6 o'clock in the evening of March 6, 1895. Various other similar studies and plans have been made.

STUDIES FOR CROSS-SECTIONS.

Numerous studies have been made in regard to the cross-section of the subway. Three types — illustrated on an adjoining page — will be alluded to here.

Type A has masonry side-walls and a roof consisting of a masonry arch with its axis parallel to that of the subway. Type B has also masonry walls, but its roof is composed of jack arches of masonry resting on steel I-beams whose axes run crosswise of the subway. Type C has a roof like that of type B, but its side-walls consist of concrete masonry strengthened by steel I-beam columns.

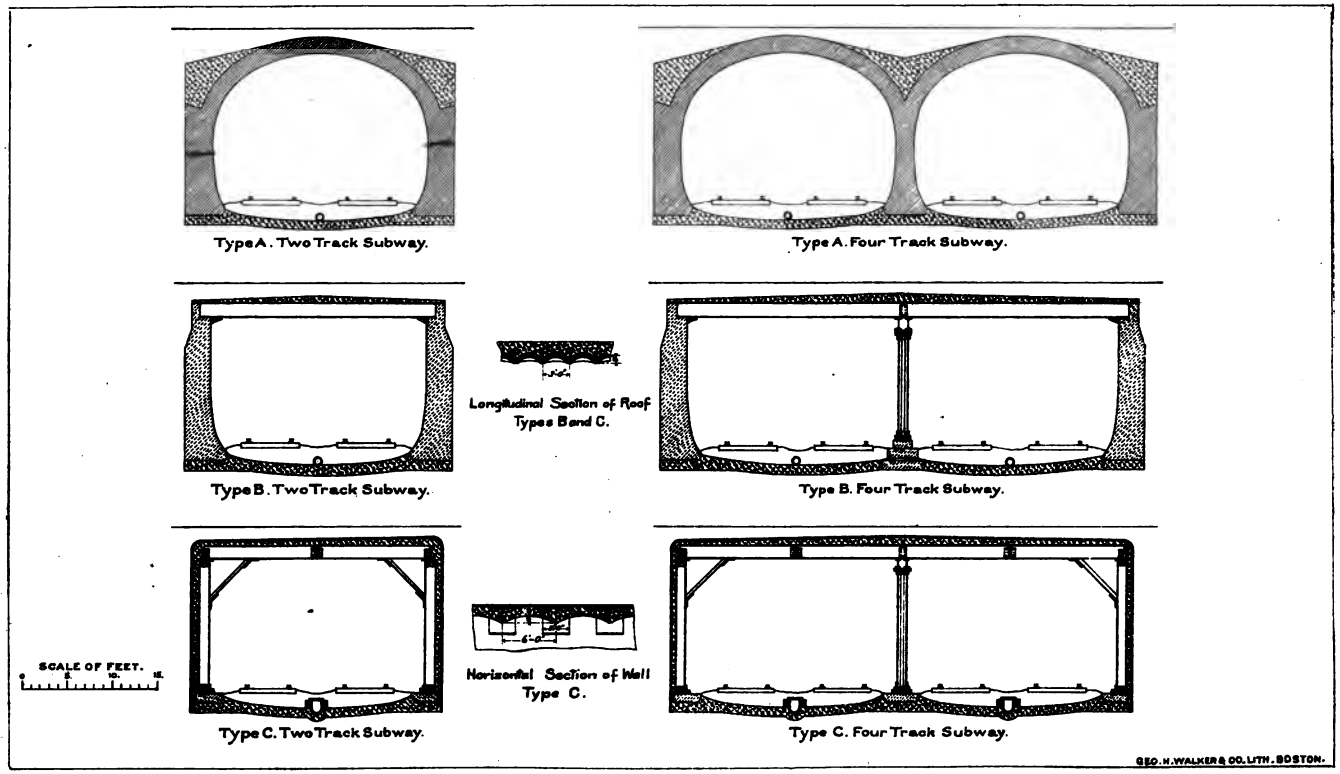
Arched masonry structures resembling type A have long been made use of in various parts of the world. One advantage of this construction is that as far as the chemical destructive agents ordinarily found in the ground and atmosphere are concerned it will last for a very long time, perhaps for centuries. Another advantage is that its arch can be built a little at a time, a characteristic that may be extremely useful in some parts of the subway. Its principal weakness consists in the fact that with such thickness and other dimensions as are practicable for the subway it requires the lateral resistance of the earth on its sides, or some substitute therefor, to resist the thrust of the arch and thus maintain its stability, and that it is liable to be crippled by unsymmetrical loading. The Commission early decided that the subway be placed as near the surface as is practicable. Among other reasons for this decision are the following: Such position causes the least amount of excavation and expense in that particular; it is least likely to injure buildings and their foundations; and it will lessen the number of stairs at the stations for the people using the subway. In many cases along the route of the subway the sidewalks are hollow, having vaults under them. An arched structure of the form of type A, and with the dimensions and thickness necessitated by subway conditions, could not stand in a position where abutments would thus be lacking, unless some substitute for these abutments should be provided. It would cripple with a very light load. Even where solid earth

abutments could at first be found, as in the Common, digging on one side for a sewer trench or similar purpose might seriously injure the arch. If placed at a sufficient depth, however, it would in many respects be an admirable construction for the subway, and where conditions require that the subway shall be placed at such a depth as to be considerably below the areas formed under the sidewalks, and so low that it is not liable to be injured by digging for sewers or other purposes, then type A can be made use of. It is also probable that type A can be used to advantage in other situations, if strengthened by steel tie rods. These tie rods, however, must necessarily be placed fourteen feet or more above the surface of the rails, so as not to interfere with the passage of the trolleys, and they introduce an objectionable feature presently to be noted in regard to types B and C.

The objection to type B, and still more to type C, is the liability of the steel beams to lose their strength by oxidation. Although iron and steel, in some situations, has been seriously injured by oxidation in a few years, yet there is ample evidence that in numerous cases it has been made to last for centuries. At least eighteen hundred years ago the Romans made use of iron cramps to strengthen the stone masonry of the Colosseum and other buildings. Most of these that were easily accessible were cut out during the Middle Ages to make weapons, but many can be found unchanged at the present time.

Lead was used to secure the cramps in position, and this in many cases served to protect the iron. Cement and concrete often served a similar purpose. Similar methods have frequently been used in Europe through succeeding ages, and abundant examples are to be found to-day in many cathedrals and elsewhere. Steel can now be had so much more easily and cheaply than formerly that, as is well known, it is far more extensively used in connection with masonry, especially in places where great strength is required in small space. It is believed that well-made cement concrete surrounding steel will protect it from ordinary rust for a long series of years. This belief is founded on personal study, and on the concurrent judgment of engineers and others who have had extended experience and who have given the subject careful attention, and is supported by the weight of material evidence.

The question of prevention of injury from electrolysis is one that demands careful attention. Mr. Isaiah H. Farnham and Messrs. Stone & Webster have been consulted in this matter. Mr. Farnham is well known for his studies and experiments in this direction. Stone & Webster have acted



TYPES OF CROSS SECTION OF SUBWAY.

as experts for the Boston Water Board and for various water companies and street railway companies. Mr. Farnham and Messrs. Stone & Webster unite in saying substantially that it is practicable and feasible to so protect the iron and steel work that it will suffer no serious corrosion by electrolytic action; that the cost of so doing will be comparatively small, and that it will be easy for competent men to determine from time to time whether or not danger from electrolysis exists.

It thus appears probable that the iron and steel used in the subway can be so protected as to last for a long time. Calculations and experiments have been made that appear to show that with the character of earth found on Section 1 and many other parts of the subway, the side-walls of concrete as arranged in type C might continue to answer every purpose, even if the steel in the side walls should almost entirely rust away.

Type C has other advantages. It has strength and stiffness to support loads and resist pressures admitting of much more definite calculations than is the case with constructions composed entirely of masonry. The strength of the steel members is, of course, to be had at once. In this respect it differs from cemented masonry construction, whose full strength is not to be had for months. With the prices of steel which prevailed last March, the cost of type C was much less than that of type A, if type A were constructed of brick. It occupies less width, and is, therefore, particularly advantageous where ample space is lacking; ample space is lacking for most of the subway route, even in the Common. Its greatest advantage, however, lies in the fact already stated, that it is not liable to be broken down by unequal loading on top or by making excavations on the side.

Several eminent and experienced engineers were consulted on this question. A majority favored the use of type C, and none opposed it, and this type was adopted for Section 1 of the subway.

The experience gained in its use on that section will of course be made use of in any similar designs which are made later. Types B and C will both probably be made use of in the work that is to follow, and type A, with or without steel tie rods, will be employed in a considerable portion of the subway.

STUDIES FOR STATIONS, TERMINALS, ARRANGEMENT OF TRACKS, ETC.

The Commission has constantly kept in view the fact that it costs but comparatively little to change plans while they exist on paper only, but that it is difficult, and entails

waste of money, to change such plans after they have been embodied in masonry and steel. There are conditions about the subway work that are somewhat novel and demand thorough study in order to insure a satisfactory solution. Having these facts in mind, a great deal of time has been spent in making studies to determine the routes to be taken and the best and most convenient ways of arranging tracks at the stations and terminals, with the object of handling in the most convenient manner the largest amount of traffic. It is proper here to state that members of the Commission have supervised and directed the studies of stations, particularly that of Boylston street, and with the especial view of avoiding grade crossings.

Twenty-three studies have been made for the Boylston-street station alone. Many of the station plans have been carefully examined by experts of long experience, for criticism and suggestion.

STATIONS AND GRADES.

A station will be placed at each of the following places: Tremont street, north of Boylston street; Tremont street, south of Park street; Scollay square; Causeway street; and at least one between the two stations last named. Additional stations may be provided in the future. The stations, as has already been intimated, will be placed as near the surface as is practicable, in order to make the distance to be descended and ascended by the passengers as small as may be, and for other reasons. It follows from the nearness of the stations one to another, and to the surface of the street, that the grades in the subway between the stations can differ but little from the grades of the street overhead. In other words, the profile of the subway must be nearly parallel to the profile of the street. In general there will be no grade steeper than 1 foot rise in 20 feet horizontal, which is slightly less steep than School street just east of Tremont.

POSSIBLE CONNECTION OF SUBWAY WITH ELEVATED RAILWAYS.

The act creating the Commission contemplates the possible use of a portion of the subway for a connection between elevated roads north of Causeway street and those south of Boylston street. For this reason the height, width, and the curves have been made such as to admit of using cars similar to those employed on the Manhattan Elevated Railroad.

The grades mentioned above are much steeper than those used on steam passenger railways, except in some cases in

difficult mountain-passes, etc., but are not nearly so difficult as some that are to be found on electrical surface railways in Boston and elsewhere.

VENTILATION OF THE SUBWAY.

The following remarks are in the main condensed from a report of Prof. S. Homer Woodbridge:

The ventilation of a subway, or tunnel, the traffic through which is by means of electrically driven cars, is a much simpler undertaking than if the motive power were furnished by steam-engines, or even by horses. A locomotive burning 35 pounds of coal per mile of run produces at a running rate of 15 miles per hour about the same quantity of carbonic gas and of water-vapor as 22,000 average adults in a state of repose, beside emitting an indefinite, though troublesome if not dangerous, amount of smoke, and sensible traces of carbon monoxide and sulphurous gases, to still further vitiate the air. If steam locomotives were to be used in the subway, probably at least 30 times as much fresh air would be required to ventilate it as with electric propulsion. Hence the somewhat plausible reasoning of some that the subway will need no other ventilation than that obtained by natural wind currents and the pumping or plunger effect of the movement of cars through it.

Another of the chief difficulties usually attending tunnel ventilation is in the case of the subway largely reduced; namely: the disturbing effect of wind, which entails that the point of ventilation shall shift with the point of maximum vitiation fluctuating to the leeward. In the case of the subway, the depressed position of the entrance-ways, both terminal and intermediate, and the protection furnished by the surroundings, will serve to lessen the effect of wind in producing air-flow through the passage, so making the conditions favorable to ventilating by means located centrally with reference to portals or other main openings.

In a general way, for purposes of ventilation, the subway for the present may be said to be divided into sections of 600 feet, each section being furnished with a fan of sufficient power, when run at moderate speed, to removethe total air-contents of its section once in ten minutes, or once in seven minutes when the fan is run at a maximum intended speed. The corresponding rates of air-currents within the subway will be from sixty to eighty-six feet linear flow a minute.

That method, making the subway itself the air-way and the velocity of flow slow, reduces the frictional and pressure work upon the fan to a minimum, and hence, also, the power

required to operate it. To provide a system for air movement and distribution which would be "theoretically" and elaborately perfect would be economically an error. Such a system might easily consume more power than the entire train of cars moving through the subway.

The number of fans may reach twelve, and the usual aggregate volume of air moved will exceed 12,000,000 cubic feet per hour, and may be made to reach 18,000,000, or a sufficient quantity to meet all demands. Additional ventilating chambers can be made, in the future, if there is any occasion therefor, or any of the present ones can be equipped with more powerful fans.

The form of fan is one chosen as the result of exhaustive tests recently made. The fan for the two-tracked sections is seven feet in diameter, and that for the four-tracked, eight feet. In action they will draw air from the tunnel and expel it through specially provided chambers and vent-shafts located at one side of the tunnel. The fans will be driven by electric motors, and each large fan will, when run at average speed, consume about the same power as a single car in motion.

The entire design has reference to ventilation by the output of vitiated air rather than the input of fresh air, the movement of one necessitating in either case a counterpart movement of the other.

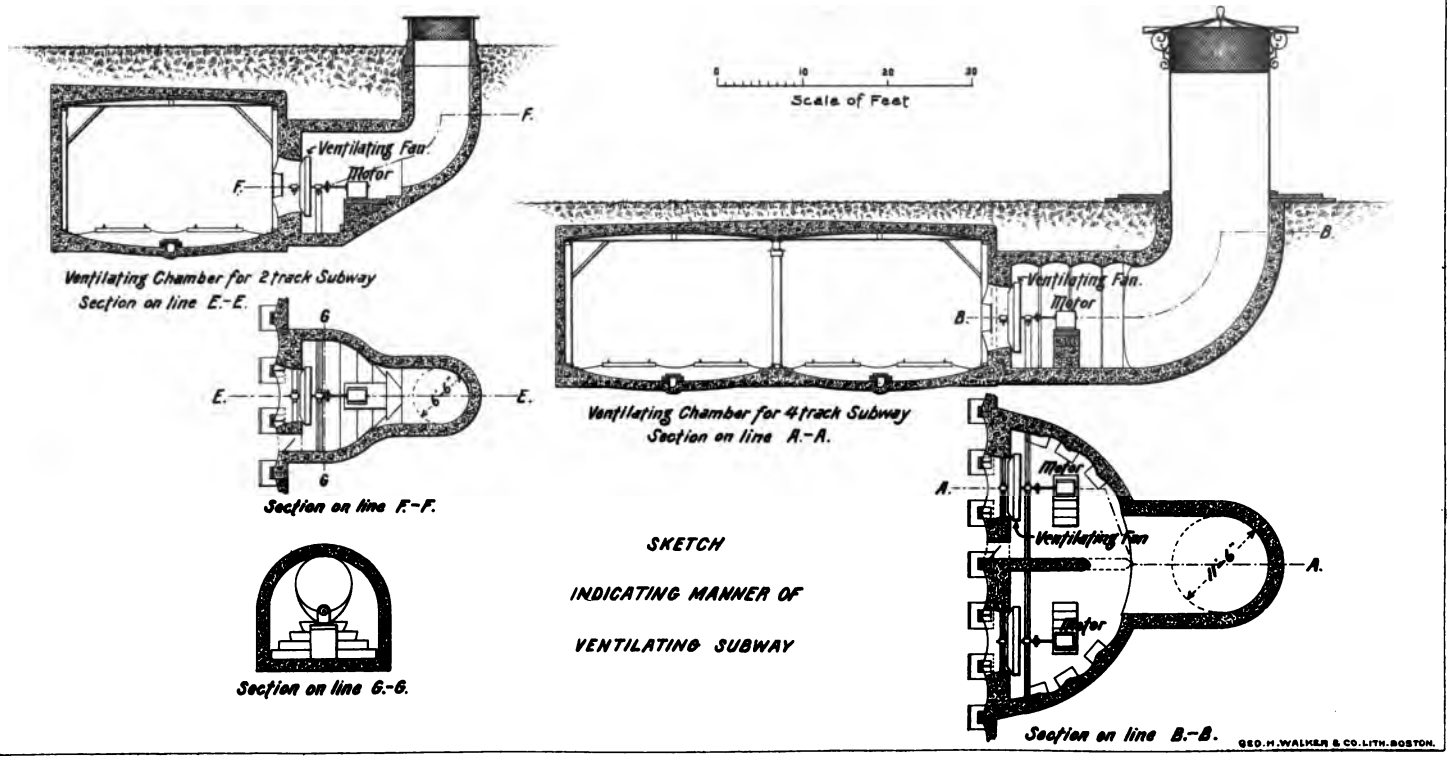
PROTECTION AGAINST PERCOLATION.

Percolation can be readily found in the best-known masonry tunnels, and other similar structures, in this country and in Europe, where they go through wet ground. As an additional precaution to keep the walls of the subway dry, its outside surface will be plastered or covered with asphalt. It is intended further to provide in wet ground small channels near this outer surface, to allow such water as does get through the outer surface to find its way readily to the subway drain-pipes without penetrating farther into the masonry.

CONSTRUCTION.

The portion of this report relating to construction on Section 1 is in the main compiled from the reports of assistants.

Location of Section 1. — Inclined open entrance to subway in Public Garden between Church street and Charles street; 2-track subway under Charles street and Boylston-street mall of Boston Common to a point about 160 feet from Tremont street, and 4-track subway under Tremont-street mall of


F.
Ventilating Fan.
Motor
F.
Ventilating Chamber for 2 track Subway
Section on line E.-E.
G
E.
E.
G
Section on line F.-F.
Section on line G.-G.
0
10
20
30
Scale of Feet
B.
Ventilating Fan.
Motor
B.
Ventilating Chamber for 4 track Subway
Section on line A.-A.
Motor
A.
Ventilating Fan
A.
Motor
Section on line B.-B.
SKETCH
INDICATING MANNER OF
VENTILATING SUBWAY
GEO. H. WALKER & CO. LITH. BOSTON.

Boston Common from a point about 110 feet north of Mason street, to a point near the southerly line of West street.

Contractors for Construction. — JONES AND MEEHAN, Jamaica Plain, Mass. Mr. Meehan, of this firm, is the superintendent.

Contractors for Steel Work. — THE PENNSYLVANIA STEEL CO., Steelton, Penn.

City Assistants:

F. B. EDWARDS, Assistant Engineer. — In charge of lines, grades, and estimates.

GUY C. EMERSON, Assistant Engineer. — In charge of inspection and construction.

E. E. YOUNG, Assistant Engineer. — Inspecting pile-driving, etc.

WILLIAM PARK. — Inspecting masonry.

A. W. PARKER. — Inspecting steel work.

G. M. BACON, Transitman.

GEORGE H. FOSS, Jr. — Looking after details of grading.

Bids and Contracts. — Bids for the steel work were opened March 9, 1895, and the contract was signed on the 23d of the same month. Bids for construction were opened March 20, 1895, and the contract was signed three days later.

Structures. — The incline is an open avenue descending from the surface of the ground opposite Church street to the subway portal. The length of the incline is 318 feet, and it descends about 17 feet in that distance. An idea of its cross-section in the deeper portion may be had from the accompanying sketch. It has granite side walls, underneath and back of which is concrete masonry, with all the deeper portion supported on a pile foundation. Its invert is of concrete, and that also rests on a pile foundation. The total number of piles in the foundation of the incline is 1,267, with an average length of about 29 feet.

The 2-track subway for Section 1 will be 24 feet to 24 feet 8 inches in width inside, 16 feet 6 inches in height along the centre, giving a clear height of 14 feet above the rails. A sketch of the cross-section of this structure is given herewith, and is of the type C alluded to in preceding pages. The exact position of the rails, and the character of their supporting material, may be considerably varied from what is shown in the illustration. The invert is of concrete, 2 feet thick at the sides, inclining toward the centre, where it is 1 foot in thickness. Along the centre, bedded in the

concrete, is a 12-inch vitrified half-pipe designed for the bottom part of a covered drain, to convey to the pump well, mentioned later, water that gets into the subway.

The side walls are composed of 15-inch steel I beams spaced 6 feet apart, standing on granite footing-stones. The intervening space between the beams is walled with Portland cement concrete in which the beams are bedded. The roof generally will be supported by 20-inch steel I beams spaced 3 feet apart, the intervening space being bridged with brick and concrete masonry.

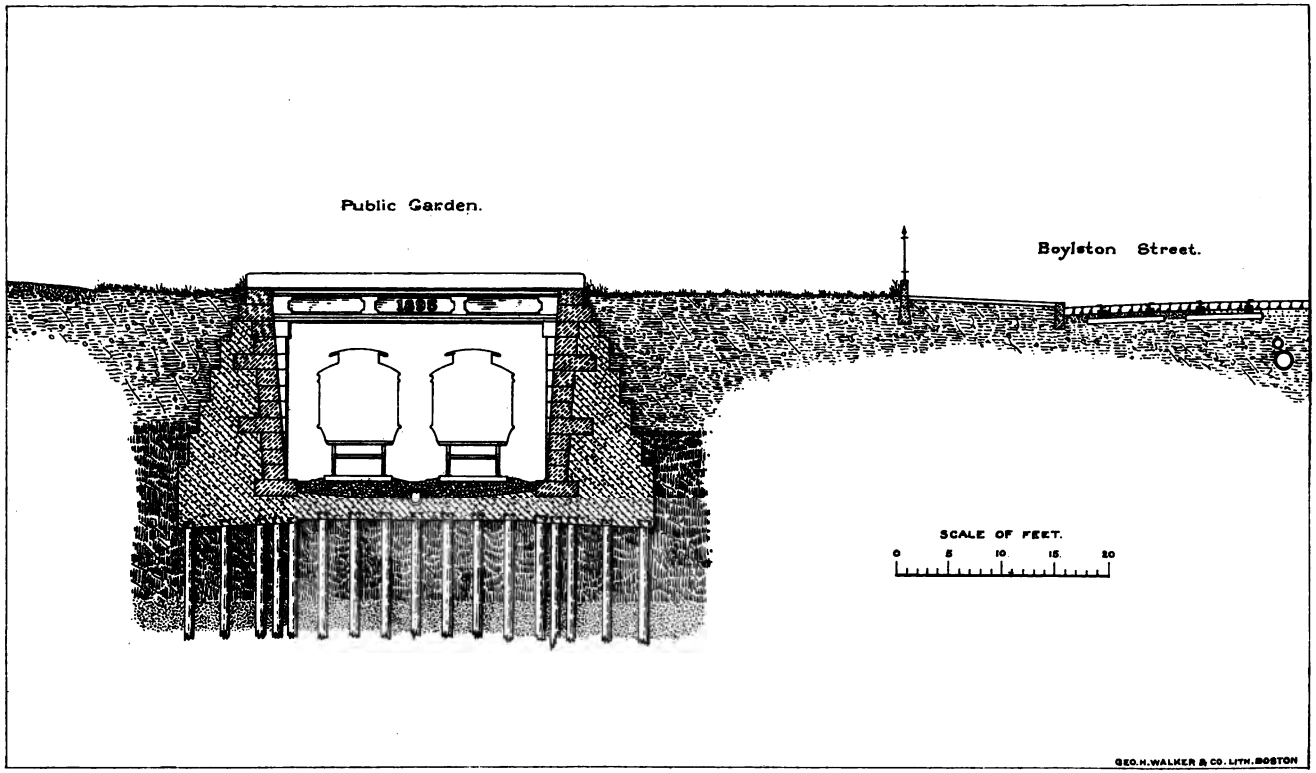
There will be a pump chamber on the northerly side of the subway in the Public Garden, near Charles street. This is nearly opposite the lowest place in Section 1 of the subway. This chamber will be 9 feet 11 inches wide, by 10 feet 8 inches long. Its side walls will be similar to those of the subway. In the lower part of the chamber is a well, the bottom of which is about 4½ feet below the bottom of the low part of the subway. This is connected by a 15-inch pipe to the channel drain, which is being laid along the bottom of the subway, in the centre. The side walls and bottom of the well are made of Portland concrete, with a lining of 8-inch brick masonry. Under ordinary circumstances the only water which will find its way to this well is rain falling into the open incline, and the leakage between the incline and Tremont street. The water pumped from this well will be discharged into the Church-street sewer.

The 4-track subway is similar to the 2-track, with the exception that its clear width is 48 feet, and that it has a row of steel columns along its centre.

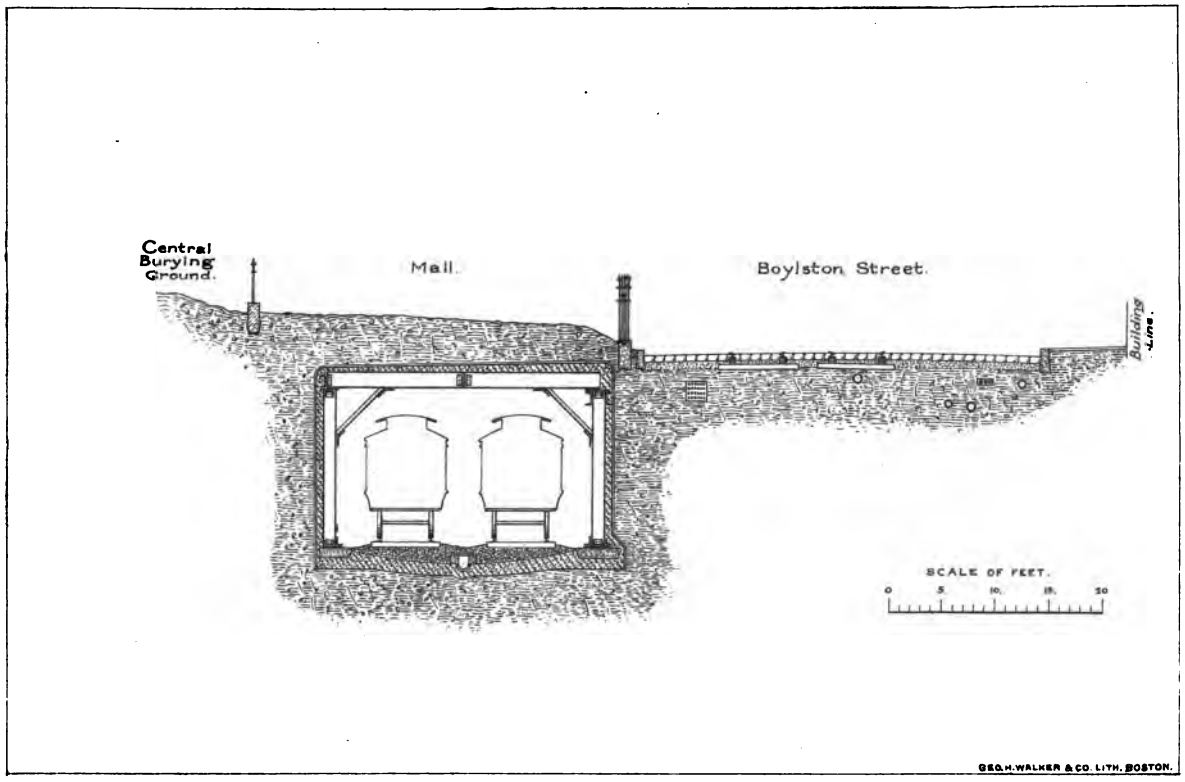
There has been completed (August 15th) of the above-mentioned structures: The pile foundation of the incline, its invert, and its side walls, with the exception of about 44 feet of coping stone and 2 cubic yards of granite facing stone; of the 2-track subway, 96 feet has been practically completed, 42 feet of invert in addition, 24 feet of masonry side walls, 42 feet of steel structure, 18 footing stones set beyond, and about 34 feet of pile foundation; the well in the lower part of the pump chamber, and the steel structure over it; of the 4-track subway, portions of the concrete invert in the two outside trenches, each portion being 8 feet wide and 75 feet long, and 26 footing stones set.

Excavation, Bracing, etc.— Earth was first dug March 28, 1895, in the Public Garden.

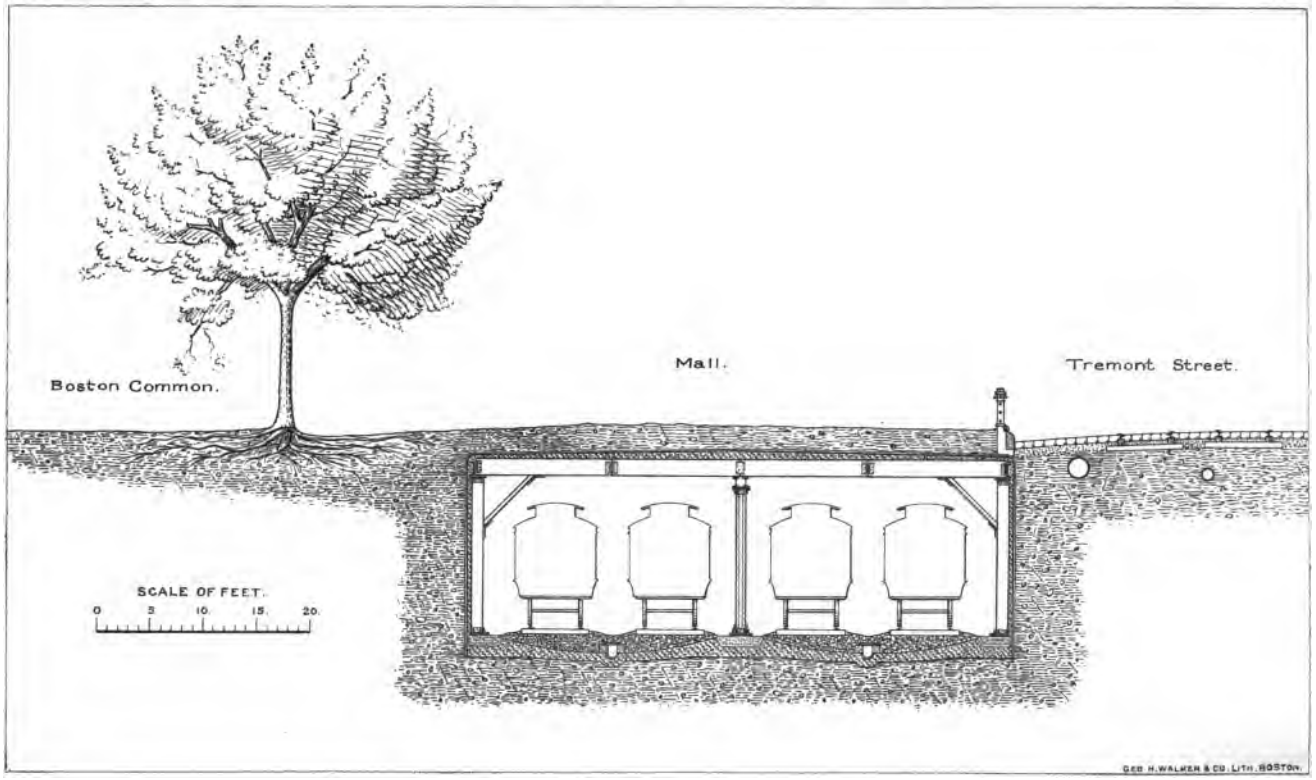
The shrubbery and trees in the Public Garden on the site of the subway were removed to leave a clear field for operations. Decayed trees were cut down, while most of the healthy trees and shrubbery were transplanted by the Super-



CROSS SECTION OF INCLINE NEAR PORTAL.



CROSS SECTION OF TWO-TRACK SUBWAY.



CROSS SECTION OF FOUR-TRACK SUBWAY,

intendent of Public Grounds to other parts of the Public Garden or the Common.

The excavation for the incline varied in width from 34 feet at the beginning to 45 feet at the portal of the subway.

The excavation for the first 11 feet from the surface, on the incline, was through filling consisting of ashes, sand, gravel, and oyster-shells. Below this was fibrous peat. From the shallow (westerly) end of the incline trench to a point where the excavation had reached a depth of about 15 feet, the sides stood without bracing. The deeper portion of the trench was sheeted with 2-inch plank, 16 feet long, and this was supported by bracing made of 8-in square spruce timber. As these braces were each about 45 feet long, they required splicing, reënforcing, and, to some extent, trussing and propping, to keep them from sagging. The Public Garden was built upon a salt marsh of fibrous peat, many square miles of which are to be found about the city. Where this has been uncovered a quantity of sulphuretted hydrogen has escaped, giving out its well-known smell. This gas, when undiluted, is injurious to the eyes and delicate membranes of the body. It is, however, a product of direct chemical action, and not of putrefaction, and its presence probably carries with it none of the dangers to the general health which are popularly ascribed to it.

The character of the excavation for the 2-track subway in the Public Garden was similar to that in the incline. Near Charles street the bottom was in hard blue clay. The excavation in the Boylston-street mall of the Common was in gravel for about 12 feet down from the surface, below which was sand. Piles were driven in a space of 34 feet to the east of the incline. The soft material found easterly from here was excavated to solid ground. This excavation was 6 feet below subway grade next to the piling, and ran to nothing in going 40 feet. This space below grade was filled with American cement concrete.

The excavation for the 4-track subway in the Tremont-street mall has been loam, gravel, and oyster-shells for the first 3 feet from the surface, and then mostly sand.

The following is the excavation which has been done: All for the incline; about 100 linear feet for the 2-track subway in the Public Garden; all excavation for the pump chamber on the northerly side of the same; about 30 linear feet for the 2-track subway near Charles street, 20 feet near the Old Public Library, 400 linear feet of trench to a depth of 14 feet below the surface of the mall; for the 4-track subway, Tremont-street mall, — southerly from West street, — about 190 feet of trench, 10 feet wide, along the

line of the easterly side-wall (next to Tremont street), and about 130 feet of trench of similar width along the line of the westerly side wall. These trenches are for the two outer walls of the subway, and in them, as has already been mentioned, the invert is being laid and the footing stones set. A third trench will be excavated along the centre line, in which the centre row of columns will be placed. Enough of the earth between the trenches will be removed to admit of placing the roof beams, and after the superstructure is completed the earth cores will be removed and the invert will be completed.

Little water was encountered until the excavation for the pump well had been nearly completed. Then a spring broke through the bottom, requiring the use of two 4-inch centrifugal pumps for a short time. This water has since been taken care of with one of these. Water was also encountered in troublesome quantities in the trench on the Common, near Charles street. This was carried away by a drainage tunnel which was made under Charles street. Before this drainage tunnel was made a 6-inch centrifugal pump was constantly required.

The methods of excavation adopted by the contractors have been as follows:

For about the first 10 feet in depth on the Public Garden work, the material was loaded into carts and hauled out at one end of the trench. After this depth had been reached, four derricks were erected along the side of the trench, their booms covering the whole work for a distance of about 425 feet. Each derrick was operated by a double drum engine. The earth was shovelled into skips, lifted to the surface, and dumped into carts. The stones in the retaining-walls, the timber, and piles and pile driver were handled with these derricks. The handling of the excavated material elsewhere has been done in a similar manner.

Cement. — The following statement shows some of the characteristics of the cement used on Section 1, as determined by tests:

Kind of concrete briquettes.	Parts Plum Island sand to cement.	Hours in air.	Tensile strength, in pounds per square inch, after being kept in water as indicated.			
			7 days.		4 months.	
			Minimum.	Average.	Minimum	Average.
Portland cement...	2 to 1	24	192	214.6	373	383.7
American cement..	1½ to 1	24	39	41.3	207	212

The sand used in the above-mentioned tests is that left after rejecting all so coarse as to be retained by a sieve having 100 meshes to the square inch, and all so fine as to pass through one having 400 meshes to the square inch.

The fineness of the cement is indicated by the following table:

Per cent. retained by sieves having meshes to the square inch as indicated.

	2,500	10,000	14,400	22,500	32,400
Portland.....	1%	13%	18%	25%	30%
American.....	8%	18%	28%		

In addition to testing the cement by samples taken from barrels in storehouse, samples are daily taken of the mortar ready for use from beds on the work.

Various other tests have been made, and as a further precaution no cement has been used except that which has had a good reputation for a series of years.

Miscellaneous. — Most of the sand and gravel entering into the concrete thus far laid has come from the subway trench in the Common.

It was provided in the contract that where human remains were removed from the trench they should be disturbed as little as was practicable, and should be guarded and protected until disposed of as directed. This provision has been carefully carried out.

The Park-square gateway and about 440 feet of the iron fence along the Boylston-street mall have been taken down and stored at the City Yard on Massachusetts avenue. The fence was made mostly of cast iron. A large part of it was in a broken condition, and the granite foundation was badly chipped and dilapidated at many places. One hundred and ninety feet of the fence along the Tremont street mall has also been removed.

The surplus earth has been used in re-grading parts of the Public Garden and Common, according to plans prepared by Olmsted, Olmsted & Eliot, Landscape Architects, and approved by the Mayor and the Superintendent of Public Grounds. Of the re-grading in the Public Garden, about 3 acres in the south-east part is nearly done. The new surface is in some places 6 feet higher than the old.

About 3,500 square feet of new paths have been made in

the Public Garden, using surface materials from the discontinued paths there and on the Common.

But little grading has been done on the Common, no part being finished.

Cost. — Latest estimates indicate that, including engineering and inspection, the cost will be as follows: Incline, about $41,000; the 2-track subway, about $122 per linear foot; the 4-track subway, about $182 per linear foot, and that the total cost of Section 1 will be about $205,000.

Progress. — It is estimated that at this date (August 15) the contractors for construction are about 20 days behind on excavation, and about 47 days behind in erecting the steel for the walls and roof of the subway. Deliveries of steel to date (August 15) have been about as follows: 86 per cent. of that for the 2-track subway, and 65 per cent. of that for the 4-track subway. These deliveries for the 4-track subway were not due until September. All of the steel for the 2-track subway was due August 8.

EAST BOSTON TUNNEL.

The act creating the Transit Commission permits it to construct a tunnel for two railway tracks from Scollay square or vicinity to Maverick square, East Boston.

The question of a tunnel to East Boston has been agitated for many years, and one would doubtless have been built before this time but for the difficulties anticipated and the great cost involved. It may, therefore, be of interest to refer briefly to some similar works that have been built elsewhere, and to consider the necessary cost of a tunnel in this locality.

In may be remarked here that tunnelling under a body of water is not necessarily more difficult than ordinary tunnelling. Numerous examples could be given of sub-aqueous tunnels in rock excavation, and some in clay, where no extraordinary difficulty occurred from the entrance of water. Wherever the bed of the stream or channel, however, consists of loose and porous material, tunnelling has always been found to be difficult and expensive.

An attempt was made as early as 1802 to tunnel under the Thames, about a mile below London Bridge, where the river is about half as wide as the distance between the East Boston North Ferry slips. After more than six years of constant labor a drift less than three feet wide, and not high enough for a man to stand erect in, had been driven only three-fourths of the way across. Much of the ground was dry and firm, but at intervals soft or porous material was encountered where inbursts of water and sand occurred. After

THE PUBLIC GARDEN ENTRANCE — MAY 16, 1895.

THE PUBLIC GARDEN ENTRANCE — JUNE 14, 1895.

IRON-WORK IN PUBLIC GARDEN — JULY 31, 1895.

IRON-WORK, ROOF, PUBLIC GARDEN — AUGUST 8, 1895.

PUBLIC GARDEN ENTRANCE — AUGUST 9, 1895.

PORTAL — PUBLIC GARDEN — AUGUST, 1895.

this the inbursts so frequently occurred that finally, in 1809, after many trials and large expenditure of money, the work was abandoned. The well-known tunnel of the elder Brunel was begun in nearly the same locality in 1825, and completed 17 years later, after encountering many dangers and difficulties. Its cross-section is a double arch 38 feet wide and 22½ feet high, both of these dimensions being outside. The portion of this tunnel under the river is said to have cost about $2,800 per linear foot.

Brunel invented and used a complicated shield, which was a most important factor in his work. Most or all of the sub-aqueous tunnels that have since been driven in soft ground have been of independent circular tubes of comparatively small diameter. Shields for such cylindrical tunnels, the art of using them, and the art of quickly building the walls of the tunnels themselves, have been greatly improved during the last 25 years. The use of compressed air for horizontal tunnelling has also added greatly to our resources for this kind of work. Notwithstanding these advances, however, sub-marine tunnelling in loose and porous material is still costly and to some extent dangerous.

A small subway, with an interior diameter of 7 feet, passing under the Thames near the Tower, in London, was constructed about 25 years ago. In this case a circular shield similar to those so often referred to at the present day was employed. Compressed air was not used.

The partially completed tunnel under the North river, between Hoboken and New York city, has an interesting history.

Active work on the tunnel proper was begun in January, 1880. It was designed to be of two tubes, each having internal dimensions of about 16 feet wide by 18 feet high. Compressed air was used (for the first time on any important tunnel) to prevent the entrance of water, and the excavation as fast as made was lined with thin steel plates, and later with brick. Two of the sub-aqueous tunnels near Boston on the Metropolitan Sewerage System were built by this method.

In June, 1880, the heading in the northerly tube had been extended 360 feet from the Hoboken shaft, but a portion near the latter was not of full size, and was being enlarged. Just after a change of shifts the compressed air blew a hole through the soft silt in the roof of the tunnel at this spot, and the water entering drowned the twenty men who were working therein.

After some delay operations were again resumed, and carried on until Mr. Park (who was furnishing the money) died in November, 1882. At this time, 1,550 feet of north

tunnel and 560 feet of south tunnel had been built in silt from the New Jersey side, and 75 feet on the New York side, under the docks, in sand and water. Mr. D. C. Haskin, who re-invented the method of tunnelling here used, and controlled the work previously done, was able to raise money in 1883 to build 100 feet more of tunnel on the New York side; and in 1887 he built 305 feet more on the New Jersey side.

Between 1888 and 1891 the northerly tunnel was extended 2,000 feet, or to about three-quarters of the way across the river, when it again stopped for lack of funds. This last instalment of the work was done with the aid of British capital and largely under the direction of British engineers. In addition to compressed air a shield was also brought into use, and the excavation in the tunnel as fast as made was lined with heavy plates of cast-iron.

About the time the latest work was in progress upon the Hudson-river tunnel two other famous tunnels were in course of construction. One of these was the St. Clair-river tunnel, between Sarnia and Port Huron, constructed under the direction of Joseph Hobson, Chief Engineer of the Grand Trunk Railway. The distance across the river at that point is about 400 feet more than between the North Ferry slips, Boston and East Boston. The tunnel proper was completed in 1890, a little over a year from the time it was begun. It is for a single line of railway track, and is 20 feet in diameter in the inside. The estimated cost was $3,000,000, which was considerably exceeded.

The City and South London tunnel is about 3½ miles long. It crosses under the Thames, just above London bridge, where the river is less than 900 feet wide, or somewhat less than half the distance between the North Ferry slips. This tunnel consists of two entirely independent parallel tubes, each having an internal diameter of only 10 feet 2 inches. It was built under the direction of Mr. J. H. Greathead, and was completed in 1890. The general method of excavation and construction for both the St. Clair and the City and South London tunnels was the same as that employed last on the Hudson-river tunnel, *i.e.*, with the use of shields and compressed air, and with walls of cast-iron plates.

The tunnel under the Mersey at Liverpool, including approaches, is about 4 miles long; but the width of the river at the point of crossing is only about 4,000 feet. The tunnel is 26 feet wide, 19 feet high, and has two tracks on which steam-cars run at present. Parliamentary authority has been granted to change this to an electrical equipment, and the company is considering whether such change will be advan-

tageous, economically and otherwise. The tunnel has a complete system of mechanical ventilation. The approaches are so arranged that railway trains can enter from the surface. In addition, there are two principal underground stations for passengers, equipped with powerful elevators. These stations can also be reached by stairways and by inclined foot-walks. The excavation for this tunnel was all or mostly in rock. A large amount of water, stated by the resident engineer to be about 7,000 gallons per minute, leaks into it, and is removed by powerful pumps. The tunnel, which was finished in 1886, is very interesting as an engineering work, but financially has proved to be a great failure.

This tunnel is reported to have cost approximately, including approaches, land, equipment, placing loans, etc., $10,000,000.

The Blackwall tunnel under the Thames, now in course of construction, is circular in section, with a diameter in the clear of 24 feet 3 inches. There will be about 1,735 feet of open approaches. A portion of the work intended to be done by the tunnel method was done by the trench method until a depth of about 65 feet was reached. Compressed air and a tunnelling shield are employed in making the excavation for the remaining 3,143 feet. The walls of the tunnel are cast-iron segments, lined with brick masonry.

The total time for completing this work will probably be about five and one-half years, and the approximate cost, not including land damages, $4,000,000.

The Glasgow Harbor tunnel consists of three tubes, each 16 feet in internal diameter. A shaft 75 feet deep is on either shore. Two of the tunnels run between the bottoms of these shafts, a distance of about 720 feet. The third tunnel connects the tops of the shafts, inclining to reach the level of the others. Its inclines have a grade of one in three, and are stepped. This third tunnel is exclusively for foot-passengers, while the others each contain a paved roadway for vehicles. The tubes here are built of cast-iron segments. The extent under the river is about 415 feet, about a third of this distance being through boulder clay. Compressed air and tunnelling shields were used.

The approximate cost of the tunnel proper for excavation and iron lining was $400 per linear foot.

Most of the tunnels mentioned were visited by the writer, and several during process of construction.

Various routes have been proposed from time to time for a tunnel to East Boston, as well as various sizes and cross-sections. To determine the best would require an elaborate and extended study and discussion. The route and sizes

outlined below appear to promise fairly both for moderate first cost and for usefulness.

An open incline from a point on Hanover street, descending at the rate of 5 feet in 100; from the end of the open incline, a double track subway to be built by open trench excavation, then a double-tube structure, each tube being 12 feet wide and 16 feet high, inside measurement, passing under the harbor. This portion could be built by dredging and putting in the tubes in sections about 50 feet in length, in a manner similar to that used in building the Metropolitan main sewer under Shirley Gut and from the southerly end of Deer Island.

The top (outside) of each tube between the harbor lines would be 35 feet or more below low water. On the East Boston side the tunnel would terminate at an open incline in Maverick square with an ascending grade of about 5 feet in 100, the sizes and methods of construction being similar to that on the Boston side.

The total length of the structure, including inclines, would be about 4,775 feet.

Each of the tubes mentioned would be wide enough to accommodate a single line of surface cars of the ordinary size, and admit of a very narrow footwalk on each side which would allow passengers to walk in case the cars should be stopped for any reason.

If at some future time the density of the travel in Hanover street should make it desirable that this structure be connected with the main body of the subway it could be done by building a subway in that street.

If the East Boston tunnel as above outlined were to be built it might cost between $2,225,000 and $2,500,000.

This tunnel could be built by the use of compressed air, a shield, and a lining of cast iron, and the conditions appear to be favorable for this method. It could also probably be built as well and perhaps more rapidly and cheaply by the method alluded to above in which pipes are made on shore, lined with masonry, have water-tight bulkheads fitted at each end, are floated out over the section of prepared trench, and sunk to position by admitting water to the interior, the sections in position being united by divers. Various engineers and others have taken part in the improvement of tunnelling by the shield method. The project of building sub-aqueous tunnels or passageways by the pipe method has also engaged the attention of a number of inventors. It was the subject of a United States patent more than 40 years ago. General Foster proposed such a method for a tunnel to East Boston more than 20 years ago, and about the same time

MAKING BORINGS FOR ESTIMATE OF COST OF EAST BOSTON TUNNEL.

prominent British engineers advocated something similar for a so-called subway between England and France.

Cost of the Subway.

Judging from such bids as have already been received, and from present contract prices, it appears probable that the cost of Sections 1, 2, and 3 will be less than the Engineer's estimate made last January.

Respectfully submitted,

Howard A. Carson,
Chief Engineer.

APPENDIX A.

STATEMENT OF THE SUBWAY COMMISSION TO THE LEGISLATURE OF 1894.

SUBWAY ACT OF 1893 INADEQUATE.

The subway act of 1893, chapter 478, provides for the construction of a subway in Tremont street, from a point at or near Pleasant street, to Scollay square (at or near which it is to connect with the surface tracks), a distance of about four thousand feet, at an expense not exceeding two million dollars. The Scollay-square end would come to the surface in a locality where it would greatly aggravate the existing congestion instead of relieving it; while the intricate network of surface rails in the already overcrowded, narrow, and crooked streets between Scollay square and the Northern station would remain in its present bad condition. Furthermore, no provision is made in this act for the cars coming into Tremont street, *via* Boylston, from Columbus and Huntington avenues, the Reservoir, Brighton, Longwood, Cambridge, and the Back Bay, all of which would have to continue as at present on the surface of Tremont street or be stopped and turned back before reaching it. As the primary reason for building a subway is to remove all cars from the surface of streets so treated, and restore the streets to ordinary city traffic, it is apparent that a subway, as authorized by this act, would be a failure, and the money expended upon it largely wasted. The lack of sufficient time to study the problem properly when the bill was drawn accounts for the imperfections of the act.

BOYLSTON-STREET CARS.

By a further, though not final, examination of the premises, it appears that all the cars passing through Boylston street from and to Columbus and Huntington avenues, the Back Bay, Cambridge, Longwood, Brighton, and the Reservoir, can be gathered into a branch subway by one or more entrances on Columbus avenue, Boylston street, or in the vicinity of the Providence station, to enter Tremont-street subway at the corner of Boylston and Tremont streets, and move on independent tracks through the city. The length of this branch subway (including approaches) would be about two thousand five hundred feet. At present the point of junction of Boylston and Charles streets and Park square is one of the most dangerous and perplexing localities in the city, both for the thousands of foot passengers going to and from the Providence station daily and for the residents of the neighborhood. Any plan for the restoration of Tremont street and for promoting accelerated car transit which did not provide for the lines last mentioned would not be entitled to serious consideration.

NORTHERN TERMINUS.

The most practicable and useful terminus at the north for the Tremont-street subway is at or near the new Northern Union station. To reach this point the subway would be continued from Scollay square to New Washington street, through Haymarket square and the old Boston & Maine station location, to Causeway street, a distance of about two thousand five hundred feet. At this station some five hundred trains daily arrive and depart with passengers from and to Northern and Eastern New England, Canada, and the Provinces. All the streets and sidewalks leading from this station to the business part of the city are inadequate for the flood of passengers and traffic compelled to use them. The city cannot long delay the opening of one or more thoroughfares from Causeway street to the south.

The plan proposed for extending the subway will go far to obviate existing evils, in respect to both passengers and vehicles. This plan is to take, by purchase or otherwise, the abandoned Haymarket-square station; to widen Canal and Haverhill streets, with sidewalks from fifteen to twenty feet in width; to extend Market street to Haverhill street; and to bring the subway to the surface at Travers street, with eight tracks between Travers and Causeway streets, — four terminal tracks to accommodate traffic to and from the Northern station, two other tracks for Charlestown, and two for Somerville and East Cambridge.

TERMINAL STATION.

The terminal station will have covered platforms from two to three hundred feet long, with about two thousand feet of side-tracks for storing cars during the less busy hours of the day, thus relieving the subway and streets of cars returning empty, but with a supply at hand for service during the busy hours, and effecting a large saving to the railway company.

If this plan for a large terminal station meets the approval of the Legislature, and is carried out, it will mark a distinct advance in the methods of handling urban passenger traffic, and will add greatly to the comfort, safety, and economy of time of passengers. The provision for outside tracks lends itself appropriately to connections with a system of elevated tracks for Charlestown, and for Somerville and East Cambridge, and the towns beyond, whenever such a system shall be built, and will be found to be an essential feature for such roads when the time comes. The widening and extending of streets and sidewalks from Haymarket square to Causeway street is not strictly a part of the subway, nor should the expense thereof properly be charged to it, but as one of the results of the plan proposed it is of great value.

OTHER STATIONS.

Besides the terminal at Causeway street, other stations will be placed on Adams and Scollay squares, or near by; at or near the corners of Tremont and Park streets, Tremont and Boylston streets, Tremont street and Shawmut avenue, at Park square, at

Berkeley street, and at such other points as further study may indicate as desirable. Citizens who have recently given their time and labor for the defence of the Common, and, indeed, through whose efforts to save it from serious invasion the subway plan originated, favor the necessary location of stations on the Common at Park and Boylston corners, recognizing the fact that the rising tide of population to the south and west of the city must have an outlet, and that sooner or later this tide, if not carried around or under the Common, will flow over it.

All these stations will have liberal stairways and platforms, and will be so located as to separate passengers going in opposite directions as is done in the New York elevated system. The descent to these platforms will be about sixteen feet, or two-thirds the height of many of the New York elevated stations. The stations will be finished in white-glazed porcelain tile or brick, lighted by electricity, and will be of sufficient dimensions to accommodate for many years the constantly increasing traffic. If properly policed, they can be kept as clean as the hallways of the best-built modern business structures.

CONSTRUCTION OF THE SUBWAY.

The subway will contain four tracks from its northern terminus to the corner of Tremont and Boylston streets. From this point the two easterly tracks will continue along Tremont street to Pleasant, while the two westerly tracks will continue along Boylston street, as already described.

In constructing the subway, it is believed that interruption of traffic, other than that of street cars, by the disturbance of the street, will not be serious. The new street surface, supported on steel columns and beams and brick arches, may be completed before the mass of earth below is excavated. Travel of all kinds — barring cars — may continue upon both sidewalks and streets, and it is believed that no point will be greatly incommoded, except for a limited time. The four-track subway is designed to be in general forty-six feet wide by fifteen high. It may be lined throughout with white-glazed porcelain tile or brick, and lighted by electricity at all hours. Examples of this sort of construction may be seen in the deposit vaults of the Exchange Building, on State street; in the basement of the Sears Building; of the Waldorf Hotel, New York; in the sub-basement, Café Savarin, of the Equitable Building, New York, which extends under Broadway, and in various other structures.

The construction of the track and road-bed in the subway will be similar to that of the best steam railroads, insuring a smoothness which is impossible on a street track, where the ties and joints are inaccessible. Since ample entrances, exits, and platforms will be provided, the present helter-skelter, dangerous, and inconvenient manner of entering and leaving cars will be done away with. The atmosphere in the subway will be warmer in winter and cooler in summer than on the surface, and without the sudden extreme changes so common in this climate.

Artificial ventilation will be used if needed.

Precautions will be taken in construction to secure dryness, by the use, if found necessary, of hollow walls, outside and inside drainage, catch-basins, and water-tight inverts. Such a subway will be in no sense a tunnel, but may be more correctly described as a basement street. Gas and sewer pipes will be excluded.

TREMONT STREET NOW A CONTINUOUS GRADE-CROSSING.

Two kinds of traffic are now contending for the use of the streets, — the ordinary city traffic and the electric-car system, — greatly to the disadvantage of both. The former cannot be put in the subway, the latter can be. Some streets, such as Tremont street, present to-day many of the conditions of a continuous grade-crossing of steam railroads, for the abolition of which the railroads and the State are paying large sums.

HIGH BUILDINGS INCREASE CONGESTION.

As the process goes on of replacing three and four story buildings with others having six, eight, ten, and twelve floors (of which there are already sundry examples), the number of people doing business within a given area is doubled and quadrupled, while the area of the adjacent streets and sidewalks remains the same. Elevated roads are a financial impossibility in the congested district, and relief can come only by cutting new streets or doubling the present ones by constructing subways. The destruction of property by the first method would be too great, while by the latter the cost would be entirely in constructing new property.

CLEARING STREETS OF USELESS TRACKS.

If the subway is built, substantially as described, there will be sundry tracks beside those of the "subwayed" streets, which will no longer be necessary and should be removed and the streets restored to their original state, thus increasing their usefulness for ordinary traffic. This result would obtain, for example, in portions of Court, Cornhill, Sudbury, Portland, Canal, Haverhill, and Boylston streets, Temple place, Park square, etc.

TROLLEY AND OTHER WIRES.

The removal of trolley and other wires from several miles of streets in the heart of the city, as a consequence of the subway, will commend itself to property owners, the Fire Department, insurance companies, as well as to the æsthetic taste of the community.

BOYLSTON-STREET MALL.

Although the proposed amendments to the Act of 1893 do not ask for the use of Boylston-street mall for the subway (such use not being essential to the plan), it is nevertheless well to call attention to the probable necessity for widening Boylston street at this point in the near future. The pressure for this widening will increase with the annual increase of the traffic which now

crowds the street, until the honorable sentiment which protects the Common from such invasion gives way to the inevitable requirements of business. This widening will postpone indefinitely all schemes for opening streets across the Common. If it should be decided to make this widening now, the subway would be placed under the mall, and the street surface would be a part of the construction. Meanwhile, the rails would remain as at present, connecting with the Washington-street tracks, till the subway is finished; and there would be no interference with the street traffic, an extremely important consideration. This would give space for fifteen or twenty foot sidewalks on Boylston street, where they are grievously needed.

ELEVATED ROAD CONNECTIONS.

As to the possible future uses of the subway, it could be connected with an elevated railroad beyond its terminals, as well as with the present surface system. The height and size of the subway, and the arrangements of the stations and the platforms, will be as well adapted for trains as for single cars. In the opinion of the engineers who have been consulted, the entrances and exits to the subway may be so arranged as to admit of being connected with an elevated road so that trains of cars might be run from the suburbs to and through the subway without change.

RENTAL OF SUBWAY.

It is understood that the loss to the West End Railway Company due to its overcrowded tracks, frequent blockades, and interference by other traffic, amounts to a large sum annually, and is constantly increasing, and that this condition is a bar to meeting the pressure for more suburban service. Slowly and intermittently moving or stationary cars not only cause a serious waste of time to passengers, but also involve a loss in wages and a waste of motive power. The Tremont-street subway, with its four tracks and its comfortable stations, will, it is confidently believed, put an end to this waste and loss as respects that route, and enable the company using it to perform its functions to the satisfaction of the public. Under a long lease any company using the subway will enjoy security of tenure now lacking. So valuable a privilege should command a rental which, with other income, will pay a fair interest upon the investment, and save the city from loss. The proposed amendments to the act provide that the amount of this rental shall be finally passed upon by the State Board of Railroad Commissioners.

INCOME FROM STATION PROPERTIES.

To meet the expenses of acquiring locations for sundry stations along the route, for the northern terminus, and for widening and extending streets, special authority is provided in the proposed amendments. As the subway would use but a portion of the surface of the properties so acquired, and no space above the first story, the city, either by sale or lease, would

receive either in purchase money or rentals a proportionate return for its investment in these properties. All such locations would be valuable for business purposes.

IMPROVEMENT OF THE COMMON.

While Tremont street is being excavated, advantage should be taken of the large amount of material, immediately at hand, to raise the grade of the parade ground on the Common. This would be done without any expense for the filling, and with economy in the construction of the subway. It is suggested that a topographical plan be prepared by Mr. Frederick Law Olmsted, Landscape Architect, for the beautifying of this flat, low land, that it may correspond in dignity with the rest of the Common. So rare an opportunity for making this important improvement at a trifling cost should not be lost.

SUMMARY OF RESULTS FROM SUBWAY.

The surface of the "subwayed" streets and parts of adjacent streets will be cleared of tracks and restored to the use of ordinary traffic. The increased value of these thoroughfares to the business of the city at large is incalculable, but must be enormous. Safety and comfort to citizens will take the place of danger, discomfort, and anxiety. The offence of putting sand and salt on the streets will cease.

Passengers by the subway will enjoy the luxury of a protected station and platform when awaiting or leaving their cars, instead of being exposed on a sidewalk or in the middle of a street; and will have comparatively rapid transit, as the present rate of movement can be more than doubled, and vexatious delays by blockades, now so frequent, avoided.

The railroad company will have north of Boylston street four tracks instead of two, and a perfect roadbed and track; exemption from delays by street traffic blockades, exemption from expense of removing snow and ice, and from the waste in wages paid, and loss of motive power when cars are idle; and will measurably avoid liability for damages by accidents. There will also be a saving by abolishing tracks made useless by the subway. The crossing of tracks at the corner of Tremont and Boylston streets, and at the Tremont House, which is a cause of frequent blockades, will be done away with.

The amendments proposed to the Act of 1893 contemplate the construction of subways, partly for two and partly for four tracks, about ten thousand feet in length, at an estimated cost of $3,500,000, and the purchase of the necessary real estate for terminals and stations at an estimated cost of $1,500,000, making a total of $5,000,000.

CHARLES H. DALTON,
THOMAS J. GARGAN,
GEORGE F. SWAIN,
Subway Commissioners.

BOSTON, February 12, 1894.

APPENDIX B.

LETTER FROM S. F. McCLEARY, ESQ., IN REGARD TO TOMBS UNDER THE BOYLSTON-STEET MALL OF THE COMMON.

BROOKLINE, MASS., November 14, 1894.

B. L. BEAL, ESQ., *Secretary, etc.:*

MY DEAR SIR: I am personally familiar with the incidents alluded to in your communication of this date, and will recite them as follows:

In the last inaugural address to the City Council of Boston, Mayor Theo. Lyman, Jr., called attention to the decayed condition of the wooden fences surrounding the Common. There were at that time — 1835 — two fences, one on each side of the malls, except that on Charles street there existed only the inner fence which was constructed to keep the cows from intruding on the malls, there was no mall on Charles street. Mayor Lyman advocated a substantial iron fence, and suggested that the abutters on the surrounding streets would contribute something towards the expense. At that date the Central burial ground extended to the line of Boylston street and was there bounded by a dead brick wall ten or twelve feet high, on the inside of which were slate tablets indicating the interments in the tombs just beneath. To-day the outside walls of these tombs are nearly coincident with the north-eastern line of Boylston street at that point. During Mayor Lyman's last year steps were taken to make a contract with Daniel Safford, a prominent iron worker of that day, to furnish and set an appropriate iron fence, and contributions were requested from the abutters as proposed.

If I am not mistaken the abutters offered to contribute if the fence would be continued along Charles street, and through the burial ground, which would cause the removal of the unsightly brick wall referred to above.

Samuel T. Armstrong was chosen Mayor for 1836, and the work of construction of this fence was at once begun. In order to secure the private subscriptions, which amounted to more than $16,000, negotiations were made by the Mayor with the owners of the tombs which would be disturbed by this improvement. There was of course great oppostion by such owners. To appease this feeling the city constructed the row of granite tombs, which now skirts the walk running from Park square to West street. These tombs were offered at cost to owners of the old tombs in compensation for the extinguishment of their sacred rights. This plan pacified all such owners except Samuel May and Thomas Holland. The pressure of public sentiment on this important improvement finally secured Mr. May's acquiescence, but nothing whatever could be done with Thomas Holland. Holland was a master-mason who resided on Carver street, and he was noted for his imperious obstinacy. He told the Mayor, who suggested that the tomb be hermetically closed without disturbing its contents, that he "would stand at the door of his tomb with a drawn sword before it should be closed, or the bones of his ancestors removed!" Mayor Armstrong was in despair. Finally the row of new granite tombs was completed, and before the assignment of any of them to the owners of the old tombs, Holland met the Mayor upon the ground, and the sore subject was renewed. The Mayor exhib-

ited the new tombs to Holland, saying, "Now, Mr. Holland, you may have the first choice of these new tombs, and I will present to you without cost the one you may select if you will agree to abandon the old one. Holland shook his head, saying he'd "like a day or two to consider." At the end of this time Holland told the Mayor that he had selected tomb No. —. The Mayor was delighted; he shook Holland by the hand and expressed his approval of the veneration he had exhibited for his ancestors. He then said, "Now, Mr. Holland, you may take your own sexton and personally supervise the removal of your family's remains from the old tomb to the new one." To which Mr. Holland replied with mingled emotion and surprise, "Mr. Mayor, you don't suppose I'm going to have my new tomb dirtied up with those old bones! No, close up the old one and let 'em be." Such was Tom Holland's shrewd thrift.

Some owners removed the remains elsewhere; many accepted the offer of the new tombs, and some allowed the old tombs to be closed with the remains within.

There is certainly one row, and probably two, of tombs beneath the Boylston-street mall; one, a mural row bordering on the street, in front of which was a walk or path, with perhaps another row opposite extending under the present burial-ground fence.

I have answered your inquiry at some length, but I could not help telling you the Holland episode. The Common fence was finished in December, 1836, at an expense of over $82,000, to which the abutters contributed over $16,000, as before stated.

It is probable that all rights in these closed tombs were extinguished by agreements with the city. What disposition shall be made of any remains found therein is a matter for consideration.

Yours very respectfully,

SAMUEL F. MCCLEARY.

APPENDIX C.

REPORT OF DR. SAMUEL A. GREEN, ON THE METHOD TO BE USED IN THE CARE OF HUMAN REMAINS FOUND UNDER THE BOYLSTON-STREET MALL.

Boston, December 20, 1894.

Boston Transit Commission:

Gentlemen, — In accordance with your request I have the honor to submit the following facts in regard to the burying ground on the Common:

This parcel of land was bought by the town in the year 1756 for a place of interment, and since then it has continued to be used for that object. The first burials were made in graves, and, so far as now can be ascertained, the earliest tombs were built about 1793. Some years later Frog lane was widened, and became Boylston street, as it is known to-day. In 1836 Boylston-street mall was laid out, and, in order to straighten the path, the mall was raised and carried over a line of tombs which stood in the way. At this time some of these tombs were emptied of their contents by the owners, while others were filled up, the remains being taken either to the new tombs built on the westerly side of the ground or to other cemeteries, or were covered up, where it was supposed they would lie undisturbed until they were completely decomposed and mingled with the surrounding soil.

There is some reason to think that, when the burying ground in question was first used as such, a few of the interments were made outside of the present limits of the Common, and presumably where the street now runs. Within the past few weeks Boylston street, on its north side near the fence, has been dug up by the Boston Electric Light Company; and I am told by creditable persons that fragments of human skulls and other bones were thrown out by the workmen. It is possible, of course, that these remains came originally from the Common, and were scattered with the earth either when Boylston street was graded or when the mall was laid out.

A subterranean passage or tunnel, under the mall along the southern border of the Common, would probably disturb the bones of many an old Bostonian, but this now cannot be helped. At the present time the question is a practical one, if the proposed plan for a subway is to be carried out, and the removal of the remains becomes a necessity. All rights in these hidden tombs, on the part of their former owners, have long since been extinguished, and no injustice would be done to the living representatives of their several families by a reburial of the remains. It goes without saying that such action, under the guidance of your Board, would be decently and respectfully done. With that end in view I would recommend that all such traces of the human body as may be found in these excavations should be carefully gathered up and placed in proper receptacles for their reinterment in the same burying ground, where presumably repose the ashes of the kindred, and that this suggestion be carried out with the same regard for the feelings of friends — so far as is practicable under existing circumstances — as was shown at the original burial, and as if each bony fragment was now fully identified with the person to whom it formerly belonged.

In regard to your question concerning risk from infection or contagion as a result of the last illness of the decedents, I would say that there would be no danger whatever to the workmen. The earth is a good disinfectant, and a burial of more than half a century would wipe out and destroy any germs of disease that might still linger after death.

Very respectfully yours,

SAMUEL A. GREEN.

APPENDIX D.

REPORT OF DR. SAMUEL A. GREEN ON THE CARE OF HUMAN REMAINS.

BOSTON, July 27, 1895.

To the Boston Transit Commission:

GENTLEMEN: The excavations in the Boylston-street mall are now so far advanced that there is little or no likelihood that more human remains will be found in that section of the work. Before the digging began, it was known that the path of the trench lay along and through a line of tombs, which were covered up nearly sixty years ago, when the mall was laid out in 1836, since which time they have been disused for further interments. For this reason it was anticipated that many human bones would be found while the work was progressing; and on that account your Board, on April 18th, placed the removal of such remains under my charge. With this preliminary statement I now have the honor to submit the following report:

On April 19th my attention was first called to the discovery of various parts of several skeletons, which were found during the forenoon of that day, or the afternoon of the preceding day, lying outside of the tombs. Steps were taken at once for the proper care of these fragments, and boxes were ordered for their final disposition. Apparently the bodies had been placed originally in the ground, though there was left hardly any trace of coffins; and it seemed probable that many of the bones had been previously disturbed. This incident was but the beginning of the discovery of other remains, which continued daily in considerable numbers for several weeks. The various parts of the skeletons were so incomplete that it is impossible now to say with any exactness how many different persons they represented, but an approximation to the number is given later in this report. In some cases the fragments were very small, and, if found elsewhere, would not have been recognized as belonging to the human frame. The special duty of collecting these remains was assigned by the contractors to two or three men who, I am satisfied, did their work faithfully; and, whenever practicable, they placed the bones of one body in a single box. In two instances (the Lowell and Tuttle tombs), where the remains in tombs were identified, they were taken by representatives of the two families, and reinterred elsewhere.

During the progress of the excavations it was found that the line of buried tombs extended from a point near the entrance to the Common, at the south-west corner, to a point nearly opposite to the old Public Library. Some of the tombs had been almost entirely destroyed, while others were in a fair or good condition. Nearly all contained coffins, which for the most part were so decayed that they could not be handled, and the enclosed bones were much decomposed. In many instances the brick arches, that once served as the top of the tombs, had been broken in, and the tombs themselves partially filled with earth, bones, stones, and other matter, and then covered over with granite slabs. So confused were the contents that it was impossible to find out the number of original interments. It was evident that such tombs had been used for the reception of bones that had been disturbed in the surrounding ground when the mall was built.

Lewis Jones & Son, undertakers, have had charge of the reburials, which were made in the adjoining burying ground on the Common, and their part of the work was done in a satisfactory manner. Fortunately it was possible to find a place in that ground where all the remains could be reinterred in a row by themselves, without disturbing other graves.

The following is an estimate of the number of bodies, either whole or represented by parts, found and reburied:

Taken from seven tombs which had not been previously disturbed	90
Other remains, for the most part previously disturbed and lying in confusion, about	820
	910

In conclusion, I wish to acknowledge the help I have received from Messrs. Jones & Meehan, the contractors, Mr. Guy C. Emerson, an assistant engineer, and Mr. Robert M. Meehan, who have coöperated with me in this matter, and have been ever ready to adopt my suggestions. Through them the work has been carried out in a manner respectful to the memory of the dead, and satisfactory to the feelings of the living.

Very respectfully yours,

SAMUEL A. GREEN.

APPENDIX E.

Copy of Inscriptions found on Tombs and Coffins, so far as legible, under the Boylston-Street Mall of the Common.

James T. Blanchard
Died Oct. 6, 1832.
Æ. 5 years.

Mrs. Sarah Blanchard

James

Solomon Hawes,
Died Jan. 30, 1834.

Zeal Skidmore
Died Feb. 7, 1827.
Æ 49 years.

Homer Evans
Æ 5 mos.

Emmaline Evans
Died Oct. 1, ——

Jane Hodgkins
Obt. Sept. 20, 1821
Æt 54 yrs.

Daniel Tuttle
Died May 10, 1823

Gideon Williams
Born Aug. 12, 1746
Died Jan. 23, 1830

Mary Parsons Haven
Died Oct. 20, 1827
Æ 21 yrs.

Eunice V. Fuller
Died Oct. 11, 1826
Æ 42 yrs.

——— Tileston

Samuel Morse
Died Jan. 4, 1826
Æ 56 yrs.

William Keith Spence Lowell
Died ——— 1823

Manshu Tucker
Died Oct. 11, 1800

Aaron Dexter (Headstone)

Mr. Rufus Tower
Died Nov. 29, 1820
Aged 63 years.

Nathaniel Waer, Junr.
Died Nov. 16th, 1823
Æ 25

Mr. William Homer
Died Augt. 22d, 1822
Aged 52

Mrs. Lydia Kimball
Died Oct. 29, 1821
Æ 64 years

Charles H. Locke.

APPENDIX F.

STATISTICS.

Table I.

GRADES OF BOSTON STREETS.

	Per Cent.
State st., opposite Exchange building, about	2.0
State st., Washington to Devonshire, north side, about	4.0
Devonshire st., Adams sq. to State st.	2.5
City sq., Charlestown, Warren ave. from R.R. to Main st.	1.6
City sq., Charlestown, Charles River ave. from Water st. northerly, 200 feet	1.9
Washington st., across Adams sq., from corner Brattle st. to corner Dock sq.	4.0
Beacon st., from Somerset to Tremont st.:	
From Somerset st., 125 feet	7.0
Average for whole length	6.6
Beacon st., from Joy to Spruce st., 695 feet	5.7
Cornhill, from Court st. to Franklin ave., 270 feet; average	4.0
Garden st.	15.0
Irving st.	15.0
Park st., from Beacon to Tremont, 144 feet from Beacon	9.3
" " " " 325 " " "	4.5
School st., from Tremont to Washington st., 100 feet	5.2
" " " " " 100 "	4.4
" " " " " 350 "	3.1
Tremont st., from Winter to Hamilton place, 150 feet	4.2
" " " 65 feet north of Temple place, 185 feet,	2.5
Washington st., from Court st. to Cornhill	3.0
" " Harvard place, 140 feet southerly	2.3
" " Franklin st., 190 feet southerly	1.3
" " West st., 170 feet southerly	1.5
" " Essex st., 180 feet northerly	1.6

Table II.

WIDTH OF STREETS AND SIDEWALKS.

	Width sidewalk.	Width roadway.	Width total.
Winter st.	8.0—9.0	19.0	36.0
North st., between Union st. and Merchants row	6.6—6.6	17.0	30.0
Exchange st.	4.0—5.0	15.0	25.0
State st., opposite Exchange building	11.7—11.2	35.0	57.9 at Kilby st.
Court st., between Ames and Sears buildings	8.0—8.8	24.9	41.7
Washington st., between Cornhill and Court sts.	8.5—9.5	23.5	41.5 at Court st.
Washington st., corner of Summer st.	9.2—10.1	40.7	60.0 north of Summer st.
Washington st., corner of Summer st.	9.1—7.9	32.5	49.5 south of Summer st.
Washington st., north side of Hanover st., near Washington st.	10.0—10.0	40.0	60.0
Portland st., near Causeway st.	7.9—7.8	34.3	50.0
Canal st., near Causeway st.	6.2—6.7	36.8	49.7
Haverhill st., near Causeway st.	8.6—8.2	32.2	49.0
Beverly st., near Causeway st.	7.0—7.0	36.0	50.0
Charlestown st., near Causeway st.	7.8—9.9	42.3	60.0
Charlestown st., near Medford st.	7.9—7.9	34.2	50.0
Kilby st., near State st.	7.0—7.1	25.2	39.3
Columbus ave., between Berkeley and Dartmouth sts.	13.0—13.0	54.0	80.0

Table III.

STATEMENT SHOWING TRAFFIC OVER BRIDGES.

6 A.M. TO 7 P.M.

Canal (Craigie's) Bridge.

	Sept. 17, 1892.	Sept. 8, 1893.	Aug. 15, 1894.
Foot-passengers	6,927	6,704	6,682
Teams	4,552	5,517	5,045
Cars	493	496	492
Car-passengers	11,221	11,928	12,570
Bicycles	.....	.....	104

Harvard Bridge.

Foot-passengers	1,487	2,515	2,115
Teams	1,576	2,690	2,771
Cars	146	270	346
Car-passengers	5,355	10,612	9,109
Bicycles	.....	.....	1,350

Prison Point Bridge.

Foot-passengers	1,735	2,883	2,200
Teams	2,104	2,121	1,867
Bicycles	.....	.....	65

West Boston Bridge.

Foot-passengers	3,584	5,428	4,429
Teams	2,953	3,015	2,660
Cars	1,059	923	1,008
Car-passengers	28,592	20,743	22,514
Bicycles	.....	.....	96

STATEMENT SHOWING TRAFFIC THROUGH BRIDGES.

		1892.	1893.	*1894.
Canal.	Openings	3,406	3,232	3,105
	Vessels	3,582	3,618	3,753
Harvard.	Openings	1,350	1,736	2,491
	Vessels	1,939	2,321	2,964
Prison Point.	Openings	493	444	498
	Vessels	601	675	1,890
West Boston.	Openings	1,652	1,709	1,890
	Vessels	2,957	2,598	2,878

*Includes December, '93, and January, '94, already included in 1893.

Table IV.

STATISTICS OF TRAVEL OVER AND THROUGH CHARLES-RIVER AND WARREN BRIDGES.

1. Statement of traffic between the hours of 6 A.M. and 7 P.M.:

Charles-River Bridge.

	June 29, 1892.	Sept. 5, 1893.	Oct. 8, 1894.
Foot-passengers from Boston	3,585	4,315	4,485
Foot-passengers to Boston	3,270	4,115	4,670
Teams from Boston	2,030	2,335	[1] .....
Teams to Boston	1,535	2,130	[1] .....

Warren Bridge.

	June 29, 1892.	Sept. 5, 1893.	Oct. 8, 1894.
Foot-passengers from Boston	7,290	5,965	8,647
Foot-passengers to Boston	7,045	7,670	8,210
Teams from Boston	3,195	3,035	5,983
Teams to Boston	3,355	3,680	5,424
Horse and electric cars from Boston	1,155	975	1,146
Horse and electric cars to Boston	1,165	1,147	1,167

2. Statement showing number and character of vessels passing through the drawbridges during the years 1891, 1892 and 1893:

Charles-River Bridge.

Kind of Vessels.	1891.	1892.	1893.	Totals.
Steamers	44	29	30	103
Sailing-vessels	3,231	2,800	2,690	8,721
Tugs	2,907	2,854	3,175	8,936
All others	2,144	2,010	2,352	6,506
Totals	8,326	7,693	8,247	24,266

Warren Bridge.

Kind of Vessels.	1891.	1892.	1893.	Totals.
Steamers	47	17	7	71
Sailing-vessels	3,108	2,796	2,655	8,559
Tugs	1,950	1,940	1,983	5,873
All others	1,757	1,470	1,520	4,747
Totals	6,862	6,223	6,165	19,250

[1] Bridge closed to team travel on October 8, 1894, during repairs.

Table V.

TRAVEL OVER AND IN VICINITY OF BRIDGES.

Warren Bridge.

December 10, 1894, 6 A.M. to 7 P.M.

	Teams.	Persons on teams.	WEST END CARS.		BOSTON & LYNN.		Foot-passengers.
			No. cars.	Passengers.	No. cars.	Passengers.	
To Boston . . .	3,075	3,665	784	19,703	278	6,689	5,368
From Boston . .	2,771	3,409	771	17,720	307	5,938	5,391
Total	5,846	7,074	1,555	37,423	585	12,627	10,759

Total vehicles of all kinds, 7,986.
Total persons, 67,883.

December 13, 1894, 6 A.M. to 7 P.M.

To Boston . . .	3,147	3,916	790	21,754	308	7,153	5,774
From Boston . .	2,785	3,399	788	19,236	299	6,574	5,873
Total	5,932	7,315	1,578	40,990	607	13,727	11,647

Total vehicles of all kinds, 8,117.
Total persons, 73,679.

Charles-River Bridge.

December 10, 1894, 6 A.M. to 7 P.M.

	Teams.	Persons on teams.	Foot-passengers.
To Boston	1,496	1,860	3,254
From Boston	1,811	2,218	3,824
Total	3,307	4,078	7,078

Total persons, 11,156.

December 13, 1894, 6 A.M. to 7 P.M.

To Boston	1,605	1,905	3,599
From Boston	1,853	2,261	3,747
Total	3,458	4,166	7,346

Total persons, 11,516.

C.													
Boylston st. at Boylston place	1,304	248	1,056	297	97	1,226	49	1,177	15	56	312	153	465
Boylston and Tremont sts.	1,218	719	499	765	906	1,234	902	332	694	2,114	1,459	3,020	4,479
Tremont and Eliot sts.	821	468	353	689	265	917	630	287	397	1,338	1,086	1,603	2,689
Tremont and Lagrange sts.	1,001	265	736	370	181	906	234	672	122	289	492	470	962
Tremont and Boylston sts.	986	381	605	433	134	900	666	234	338	2,132	771	2,266	3,037
Tremont st. at Masonic Temple	2,049	829	1,220	1,223	617	...	....	....	....	.....	1,223	617	1,840
Tremont and Mason sts.	2,063	694	1,369	949	314	2,054	507	1,547	296	857	1,245	1,171	2,416
Total	....	3,604	5,838	4,726	2,514	....	2,988	4,249	1,862	6,786	6,588	9,300	15,888
D.													
Tremont and West sts.	2,159	1,356	803	4,781	470	2,111	1,344	767	397	3,452	5,178	3,922	9,100
Tremont st. and Temple place	2,224	1,450	774	4,731	895	2,164	1,524	640	452	4,811	5,183	5,706	10,889
Tremont and Winter sts.	2,205	1,514	691	5,327	1,316	2,229	1,638	591	1,072	5,051	6,399	6,367	12,766
Tremont st. and Granary	1,025	....	....	11,595	....	1,029	....	....	....	14,215	11,595	14,215	25,810
Tremont and Bromfield sts.	1,200	839	361	1,417	1,166	1,286	928	358	1,013	2,498	2,430	3,664	6,094
Total	....	5,159	2,629	27,851	3,847	....	5,434	2,356	2,934	30,027	30,785	33,874	64,659
E.													
Tremont st. at School st.	1,266	955	311	2,315	1,349	1,251	975	276	905	2,470	3,220	3,819	7,039
Tremont st. at Museum	1,195	701	494	1,031	852	1,155	583	572	263	2,450	1,294	2,302	3,596
Scollay sq.	1,304	955	349	2,644	793	2,276	1,916	360	5,350	4,910	7,994	5,703	13,697

Table VI.

COUNT OF CARS AND PASSENGERS, ON ROUTE OF THE SUBWAY, DECEMBER, 1895, MADE BY ORDER OF THE COMMISSION.

	INWARD (NORTH).					OUTWARD (SOUTH).					TOTAL.		
	Cars.	Stops.	No stops.	Off.	On.	Cars.	Stops.	No stops.	Off.	On.	Off.	On.	Total.
A.													
Shawmut ave. and Pleasant st.	294	119	175	126	50	298	163	135	84	206	210	256	466
Tremont st. at Pleasant st.	590	300	290	273	344	603	246	357	225	143	498	487	985
Shawmut ave. and Tremont st. at Warrenton st.	928	282	646	171	178	1,045	338	707	137	637	308	815	1,123
Tremont and Hollis sts.	975	332	643	282	380	1,031	416	615	484	280	726	660	1,386
Total	....	1,033	1,754	852	952	....	1,163	1,814	930	1,266	1,782	2,218	4,000
B.													
Boylston st. at Church st.	1,301	936	365	1,613	1,195	1,191	905	286	622	1,832	2,235	3,027	5,262
B 1.													
Park sq. at Providence st.	269	180	89	189	395	359	298	61	608	483	797	878	1,675
Boylston st. at Charles st.	1,024	289	735	412	280	1,126	664	462	199	1,242	611	1,522	2,133
Boylston st. at Carver st.	1,291	275	1,016	258	210	1,206	278	928	153	455	411	665	1,076
Total	....	744	1,840	859	885	....	1,240	1,451	960	2,180	1,819	3,065	4,884

C.													
Boylston st. at Boylston place	1,304	248	1,056	297	97	1,226	49	1,177	15	56	312	153	465
Boylston and Tremont sts.	1,218	719	499	765	906	1,234	902	332	694	2,114	1,459	3,020	4,479
Tremont and Eliot sts.	821	468	353	689	265	917	630	287	397	1,338	1,086	1,603	2,689
Tremont and Lagrange sts.	1,001	265	736	370	181	906	234	672	122	289	492	470	962
Tremont and Boylston sts.	986	381	605	433	134	900	666	234	338	2,132	771	2,266	3,037
Tremont st. at Masonic Temple	2,049	829	1,220	1,223	617	...	....	....	....	.....	1,223	617	1,840
Tremont and Mason sts.	2,063	694	1,369	949	314	2,054	507	1,547	296	857	1,245	1,171	2,416
Total	....	3,604	5,838	4,726	2,514	....	2,988	4,249	1,862	6,786	6,588	9,300	15,888
D.													
Tremont and West sts.	2,159	1,356	803	4,781	470	2,111	1,344	767	397	3,452	5,178	3,922	9,100
Tremont st. and Temple place	2,224	1,450	774	4,731	895	2,164	1,524	640	452	4,811	5,183	5,706	10,889
Tremont and Winter sts.	2,205	1,514	691	5,327	1,316	2,229	1,638	591	1,072	5,051	6,399	6,367	12,766
Tremont st. and Granary	1,025	....	....	11,595	....	1,029	....	....	....	14,215	11,595	14,215	25,810
Tremont and Bromfield sts.	1,200	839	361	1,417	1,166	1,286	928	358	1,013	2,498	2,430	3,664	6,094
Total	....	5,159	2,629	27,851	3,847	....	5,434	2,356	2,934	30,027	30,785	33,874	64,659
E.													
Tremont st. at School st.	1,266	955	311	2,315	1,349	1,251	975	276	905	2,470	3,220	3,819	7,039
Tremont st. at Museum	1,195	701	494	1,031	852	1,155	583	572	263	2,450	1,294	2,302	3,596
Scollay sq.	1,304	955	349	2,644	793	2,276	1,916	360	5,350	4,910	7,994	5,703	13,697

Table VI.

COUNT OF CARS AND PASSENGERS, ON ROUTE OF THE SUBWAY, DECEMBER, 1895, MADE BY ORDER OF THE COMMISSION.

	INWARD (NORTH).					OUTWARD (SOUTH).					TOTAL.		
	Cars.	Stops.	No stops.	Off.	On.	Cars.	Stops.	No stops.	Off.	On.	Off.	On.	Total.
A.													
Shawmut ave. and Pleasant st.	294	119	175	126	50	298	163	135	84	206	210	256	466
Tremont st. at Pleasant st.	590	300	290	273	344	603	246	357	225	143	498	487	985
Shawmut ave. and Tremont st. at Warrenton st.	928	282	646	171	178	1,045	338	707	137	637	308	815	1,123
Tremont and Hollis sts.	975	332	643	282	380	1,031	416	615	484	280	726	660	1,386
Total	....	1,033	1,754	852	952	....	1,163	1,814	930	1,266	1,782	2,218	4,000
B.													
Boylston st. at Church st.	1,301	936	365	1,613	1,195	1,191	905	286	622	1,832	2,235	3,027	5,262
B 1.													
Park sq. at Providence st.	269	180	89	189	395	359	298	61	608	483	797	878	1,675
Boylston st. at Charles st.	1,024	289	735	412	280	1,126	664	462	199	1,242	611	1,522	2,133
Boylston st. at Carver st.	1,291	275	1,016	258	219	1,206	278	928	158	455	411	665	1,076
Total	....	744	1,840	859	885	....	1,240	1,451	960	2,180	1,819	3,065	4,884

C.													
Boylston st. at Boylston place	1,304	248	1,056	297	97	1,226	49	1,177	15	56	312	153	465
Boylston and Tremont sts.	1,218	719	499	765	906	1,234	902	332	694	2,114	1,459	3,020	4,479
Tremont and Eliot sts.	821	468	353	689	265	917	630	287	397	1,338	1,086	1,603	2,689
Tremont and Lagrange sts.	1,001	265	736	370	181	906	234	672	122	289	492	470	962
Tremont and Boylston sts.	986	381	605	433	134	900	666	234	338	2,132	771	2,266	3,037
Tremont st. at Masonic Temple	2,049	829	1,220	1,223	617	. . .	. . . .	. . . . .	. . . .	. . . . .	1,223	617	1,840
Tremont and Mason sts.	2,063	694	1,369	949	314	2,054	507	1,547	296	857	1,245	1,171	2,416
Total	. . . .	3,604	5,838	4,726	2,514	. . . .	2,988	4,249	1,862	6,786	6,588	9,300	15,888
D.													
Tremont and West sts.	2,159	1,356	803	4,781	470	2,111	1,344	767	397	3,452	5,178	3,922	9,100
Tremont st. and Temple place	2,224	1,450	774	4,731	895	2,164	1,524	640	452	4,811	5,183	5,706	10,889
Tremont and Winter sts.	2,205	1,514	691	5,327	1,316	2,229	1,638	591	1,072	5,051	6,399	6,367	12,766
Tremont st. and Granary	1,025	. . . .	. . . .	11,595	. . . .	1,029	. . . .	. . . .	. . . .	14,215	11,595	14,215	25,810
Tremont and Bromfield sts.	1,200	839	361	1,417	1,166	1,286	928	358	1,013	2,498	2,430	3,664	6,094
Total	. . . .	5,159	2,629	27,851	3,847	. . . .	5,434	2,356	2,934	30,027	30,785	33,874	64,659
E.													
Tremont st. at School st.	1,266	955	311	2,315	1,349	1,251	975	276	905	2,470	3,220	3,819	7,039
Tremont st. at Museum	1,195	701	494	1,031	852	1,155	583	572	263	2,450	1,294	2,302	3,596
Scollay sq.	1,304	955	349	2,644	793	2,276	1,916	360	5,350	4,910	7,994	5,703	13,697

Table VI.

COUNT OF CARS AND PASSENGERS, ON ROUTE OF THE SUBWAY, DECEMBER, 1895, MADE BY ORDER OF THE COMMISSION.

	INWARD (NORTH).					OUTWARD (SOUTH).					TOTAL.		
	Cars.	Stops.	No stops.	Off.	On.	Cars.	Stops.	No stops.	Off.	On.	Off.	On.	Total.
A.													
Shawmut ave. and Pleasant st.	294	119	175	126	50	298	163	135	84	206	210	256	466
Tremont st. at Pleasant st.	590	300	290	273	344	603	246	357	225	143	498	487	985
Shawmut ave. and Tremont st. at Warrenton st.	928	282	646	171	178	1,045	338	707	137	637	308	815	1,123
Tremont and Hollis sts.	975	332	643	282	380	1,031	416	615	484	280	726	660	1,386
Total	....	1,033	1,754	852	952	....	1,163	1,814	930	1,266	1,782	2,218	4,000
B.													
Boylston st. at Church st.	1,301	936	365	1,613	1,195	1,191	905	286	622	1,832	2,235	3,027	5,262
B 1.													
Park sq. at Providence st.	269	180	89	189	395	359	298	61	608	483	797	878	1,675
Boylston st. at Charles st.	1,024	289	735	412	280	1,126	664	462	199	1,242	611	1,522	2,133
Boylston st. at Carver st.	1,291	275	1,016	258	210	1,206	278	928	153	455	411	665	1,076
Total	....	744	1,840	859	885	....	1,240	1,451	960	2,180	1,819	3,065	4,884

C.													
Boylston st. at Boylston place	1,304	248	1,056	297	97	1,226	49	1,177	15	56	312	153	465
Boylston and Tremont sts.	1,218	719	499	765	906	1,234	902	332	694	2,114	1,459	3,020	4,479
Tremont and Eliot sts.	821	468	353	689	265	917	630	287	397	1,338	1,086	1,603	2,689
Tremont and Lagrange sts.	1,001	265	736	370	181	906	234	672	122	289	492	470	962
Tremont and Boylston sts.	986	381	605	433	134	900	666	234	338	2,132	771	2,266	3,037
Tremont st. at Masonic Temple	2,049	829	1,220	1,223	617	. . .	. . . .	. . . .	. . . .	. . . . .	1,223	617	1,840
Tremont and Mason sts.	2,063	694	1,369	949	314	2,054	507	1,547	296	857	1,245	1,171	2,416
Total	. . . .	3,604	5,838	4,726	2,514	. . . .	2,988	4,249	1,862	6,786	6,588	9,300	15,888
D.													
Tremont and West sts.	2,159	1,356	803	4,781	470	2,111	1,344	767	397	3,452	5,178	3,922	9,100
Tremont st. and Temple place	2,224	1,450	774	4,731	895	2,164	1,524	640	452	4,811	5,183	5,706	10,889
Tremont and Winter sts.	2,205	1,514	691	5,327	1,316	2,229	1,638	591	1,072	5,051	6,399	6,367	12,766
Tremont st. and Granary	1,025	. . . .	. . . .	11,595	. . . .	1,029	. . . .	. . . .	. . . .	14,215	11,595	14,215	25,810
Tremont and Bromfield sts.	1,200	839	361	1,417	1,166	1,286	928	358	1,013	2,498	2,430	3,664	6,094
Total	. . . .	5,159	2,629	27,851	3,847	. . . .	5,434	2,356	2,934	30,027	30,785	33,874	64,659
E.													
Tremont st. at School st.	1,266	955	311	2,315	1,349	1,251	975	276	905	2,470	3,220	3,819	7,039
Tremont st. at Museum	1,195	701	494	1,031	852	1,155	583	572	263	2,450	1,294	2,302	3,596
Scollay sq.	1,304	955	349	2,644	793	2,276	1,916	360	5,350	4,910	7,994	5,703	13,697

Table VI. — *Continued.*

	Inward (North).					Outward (South).					Total.		
	Cars.	Stops.	No stops.	Off.	On.	Cars.	Stops.	No stops.	Off.	On.	Off.	On.	Total.
E. — *Continued.*													
Cornhill, near head	1,217	1,199	18	654	3,552	....	....	....	....	.....	654	3,552	4,206
Hanover and Court sts.	1,009	667	342	991	1,068	296	173	123	279	205	1,270	1,273	2,543
Court and Howard sts.	1,158	655	503	942	1,753	580	272	308	179	510	1,121	2,263	3,384
Sudbury st., at Court st.	1,187	593	594	625	1,410	693	234	459	215	445	840	1,855	2,695
Sudbury st., at Hawkins st.	1,134	166	968	176	238	544	49	495	6	27	244	265	509
Sudbury st., at Bowker st.	789	14	775	13	9	361	6	355	9	5	22	14	36
Hanover and Elm sts.	1,009	324	685	376	145	293	56	238	22	56	398	201	599
Portland st., near Hanover st.	654	214	440	242	149	....	....	....	....	.....	242	149	391
Total	....	6,443	5,479	10,009	11,318	....	4,263	3,186	7,290	10,078	17,299	21,396	38,695
E 1.													
Cornhill, at foot	....	....	....	....	....	1,220	750	470	602	1,176	602	1,176	1,778
Adams sq.	1,199	846	353	1,715	926	20	19	1	74	.....	1,789	926	2,715
Washington and Elm sts.	1,912	485	1,427	294	541	1,216	375	841	462	255	756	796	1,552
Total	....	1,331	1,780	2,009	1,467	....	1,144	1,312	1,138	1,431	3,147	2,898	6,045

F.													
Washington and Hanover sts.	2,179	1,369	810	672	2,988	1,152	616	536	468	799	1,140	3,787	4,927
F 1.													
Sudbury and Portland sts.	1,664	196	1,668	123	334	396	39	357	22	32	145	366	511
Sudbury st., near Merrimac st.	730	311	419	571	5	. . . .	. . . .	. . . .	. . . .	. . . . .	571	5	576
Washington and Union sts.	1,905	744	1,161	827	955	573	208	365	133	226	960	1,181	2,141
Market and Friend sts.	493	119	374	192	9	. . . .	. . . .	. . . .	. . . .	. . . . .	192	9	201
Old Haymarket sq. Station	1,172	73	1,099	214	32	. . . .	. . . .	. . . .	. . . .	. . . . .	214	32	246
Canal st., near Market st.	1,246	132	1,114	178	29	. . . .	. . . .	. . . .	. . . .	. . . . .	178	29	207
Canal and Travers sts.	1,332	130	1,202	146	23	. . . .	. . . .	. . . .	. . . .	. . . . .	146	23	169
Portland and Merrimac sts.	. . . .	. . . .	. . . .	. . . . .	. . . .	1,127	143	984	39	144	39	144	183
Total	. . . .	1,705	7,037	2,251	1,387	. . . .	390	1,706	194	402	2,445	1,789	4,234
G.													
Union Station	1,616	1,559	57	11,692	995	1,514	1,453	61	1,012	14,241	12,704	15,236	27,940

Table VI. — *Concluded.*

Summary.

	Inward (North).					Outward (South).					Total.		
	Cars.	Stops.	No stops.	Off.	On.	Cars.	Stops.	No stops.	Off.	On.	Off.	On.	Total.
A	2,787	1,033	1,754	852	952	2,977	1,163	1,814	930	1,266	1,782	2,218	4,000
B	1,301	936	365	1,613	1,195	1,191	905	286	622	1,832	2,235	3,027	5,262
B 1	2,584	744	1,840	859	885	2,691	1,240	1,451	960	2,180	1,819	3,065	4,884
C	9,442	3,604	5,838	4,726	2,514	7,237	2,988	4,249	1,862	6,786	6,588	9,300	15,888
D	8,813	5,159	2,629	27,851	3,847	8,819	5,434	2,356	2,934	30,027	30,785	33,874	64,659
E	11,922	6,443	5,479	10,009	11,318	7,449	4,263	3,186	7,290	10,078	17,299	21,396	38,695
E 1	3,111	1,331	1,780	2,009	1,467	2,456	1,144	1,312	1,138	1,431	3,147	2,898	6,045
F	2,179	1,369	810	672	2,988	1,152	616	536	468	799	1,140	3,787	4,927
F 1	8,742	1,705	7,037	2,251	1,387	2,096	390	1,706	194	402	2,445	1,789	4,234
G	1,616	1,559	57	11,692	995	1,514	1,453	61	1,012	14,241	12,704	15,236	27,940
Total	.....	23,883	27,589	62,534	27,548	.....	19,596	16,957	17,410	69,042	79,944	96,590	176,534

Maximum Hour.

	Park-st. Station.	Scollay Square.	Union Station.
On, outward	5–6 P.M., 3,406	6–7 P.M., 1,950	10–11 A.M., 1,613.
Off, inward	8–9 A.M., 3,450	8–9 A.M., 1,447	5– 6 P.M., 1,568.

Table VII.

STATISTICS OF TRAFFIC TO AND FROM UNION STATION.

6 A.M. to 12 P.M.

Date.	Cars.	Passengers to.	Av. per car.	Passengers from.	Av. per car.	[1]Total.	Av. per car.
Nov. 2, 1893 . .	847	6,675	7.88	8,551	10.10	15,226	9.01
June 4, 1894 . .	932	9,128	9.79	11,820	12.68	20,948	11.23
June 9, 1894 . .	1,066	10,637	9.98	12,965	12.16	23,602	11.07
Nov. 17, 1894 . .	1,144	10,558	9.23	12,507	10.93	23,065	10.07
Total	3,989	36,998	9.28	45,843	11.51	[1]82,841	10.38

[1]Total number of cars for this column is twice the daily figures.

4 P.M. to 7 P.M.

Jan. 18, 1894 . .	183	1,989	10.87	1,507	8.23	3,496	9.55
Nov. 17, 1894 . .	208	3,424	16.46	1,805	8.68	5,229	12.57
Total	391	5,413	13.84	3,312	8.47	[1]8,725	11.15

[1]See footnote above.

Table VIII.

CAR TRAFFIC, 6 A.M. TO 12 P.M., NOVEMBER 21, 1894, OVER WARREN BRIDGE.

	Cars.	Direction.	Passengers.	Av. per car.	Total.	Av. per car.
	1,026 W. E.	From.	19,882	19.37		
	360 L. & B.	From.	6,775	18.26	26,657	19.25
	1,028 W. E.	To.	18,287	17.78		
	360 L. & B.	To.	6,371	17.69	24,658	17.76
Total	2,774		51,315		51,315	18.49

Table IX.

AVERAGE TIME CONSUMED BETWEEN CERTAIN POINTS BY CARS OF WEST END STREET RAILWAY.

Minutes.

	Nov. 26.	Nov. 27.	Nov. 28.
Tremont street and Shawmut avenue to Union Station and return	32.00	33.42	32.55
Tremont street and Shawmut avenue to Tremont House and return	14.27	14.32	14.54
Park square to Union Station and return	30.21	32.07	30.84
Park square to Scollay square and return	17.78	19.88	19.10
Park square to Tremont House and return	12.80	13.62	13.45

Table X.

NUMBER OF WEST END STREET RAILWAY CARS PASSING VARIOUS JUNCTIONS.

PLACES.	MAXIMUM TRIPS PER HOUR.				TOTAL PER DAY.			
	North.	South.	East.	West.	North.	South.	East.	West.
Junction Shawmut ave. and Tremont st.	85	85	. . .	. . .	912	942		
Tremont and Eliot sts.	71	85	. . .	. . .	863	946		
Tremont and Boylston sts.	183	197	. . .	. . .	2,144	2,227		
Junction Park sq., Boylston and Charles sts.	112	112	. . .	. . .	1,285	1,285		
Tremont st. and Temple place	215	191	. . .	. . .	2,613	2,219		
Tremont House	216	183	. . .	. . .	2,600	2,135		
Scollay sq. and Cornhill	187	116	. . .	. . .	2,230	1,302		
Scollay sq. and Hanover st.	119	72	. . .	. . .	1,503	937		
Portland and Hanover sts.	86	24	. . .	. . .	1,010	299		
Portland and Sudbury sts.	62	105	. . .	. . .	711	1,234		
Hanover and Washington sts.	134	93	24	24	1,851	1,349	297	297
Merrimac and Washington sts.	119	76	. . .	. . .	1,637	1,114		

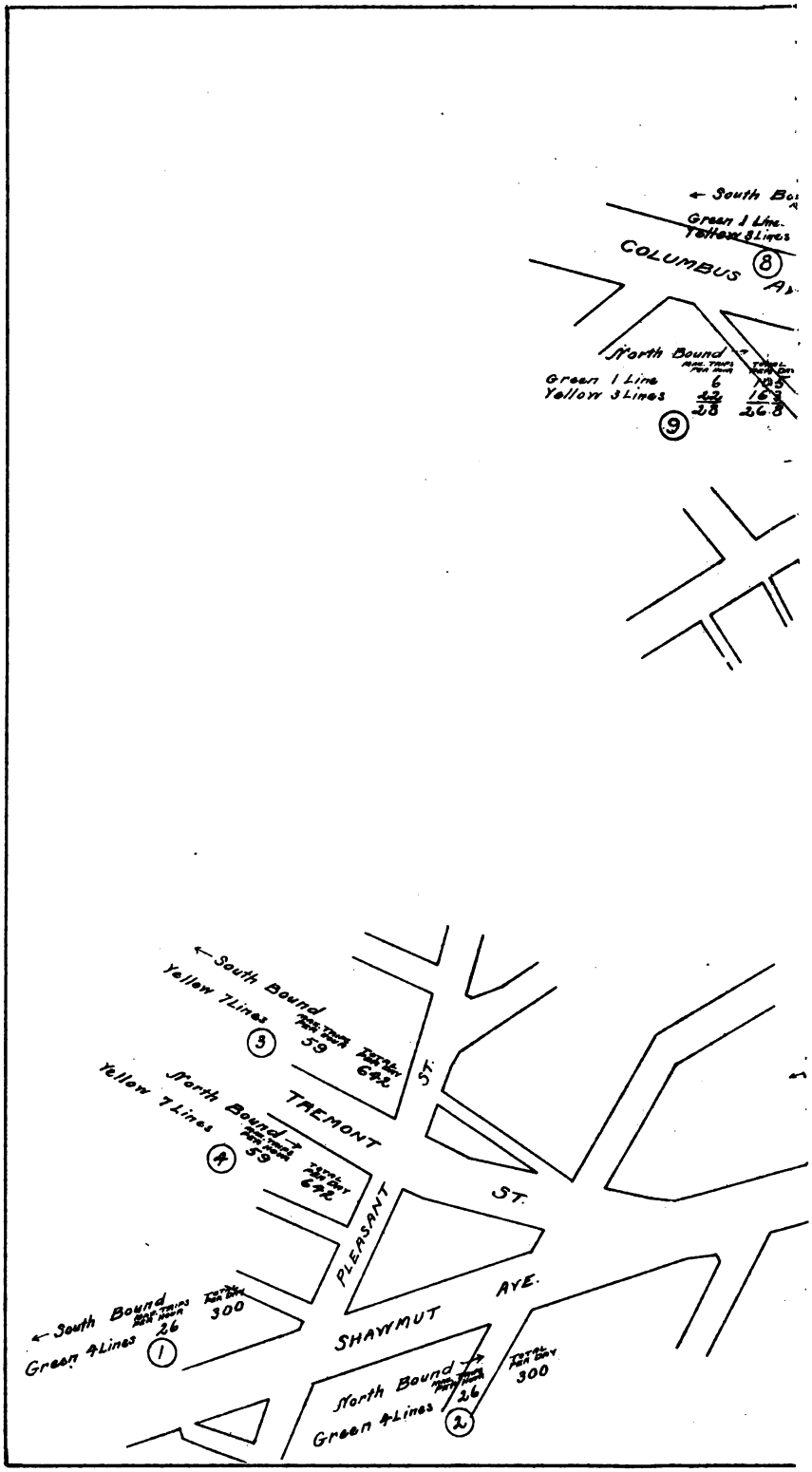

← South Bo
Green 1 Line
Yellow 3 Lines
COLUMBUS
8
North Bound
Green 1 Line
Yellow 3 Lines
9
← South Bound
Yellow 7 Lines
3
59
TAEMONT
ST.
North Bound →
Yellow 7 Lines
4
59
PLEASANT
ST.
AVE.
← South Bound
Green 4 Lines
26
300
1
SHAWMUT
North Bound →
Green 4 Lines
26
300
2

Table XI.

Travel, Stations, and Stairways of the Manhattan Railway Company.

Line.	Station.	Direction.	Traffic per day.	Busiest Hour.		Platforms.		Stairways.			
				Time.	Traffic.	Width.	Length.	Width.	No. of risers, 1st flight.	No. of risers, 2d flight.	No. of risers, 3d flight.
Second ave.	Grand st. . .	Up	4,360	6 to 7 P.M.	800	6 ft. 6 in. to 11 ft.	226 ft.	4 ft.	17	19	
Second ave.	80th st.	Down . .	8,615	7 to 8 A.M.	2,500	12 ft.	176 ft.	3 ft. 8 in.	15	22	
Third ave.	City Hall . . .	Term. . .	27,000	5 to 6 P.M.	3,700	16 ft.	240 ft.	5 ft.	13	19	
Third ave.	116th st. . . .	Down . .	13,420	7 to 8 A.M.	2,600	7 ft. to 13 ft.	185 ft.	5 ft.	12	14	11
Sixth ave.	Cortlandt st. .	Up	13,440	5 to 6 P.M.	2,000	7 ft. 6 in.	165 ft.	3 ft. 5 in.	11	9	14
Sixth ave.	125th st. . . .	Down . .	15,460	7 to 8 A.M.	2,700	14 ft. 6 in.	250 ft.	4 ft. 4 in.	14	14	[1] 16
Ninth ave.	Cortlandt st. .	Up	4,560	5 to 6 P.M.	1,100	5 ft. to 12 ft.	200 ft.	4 ft.	12	4	18
Ninth ave.	42d st.	Down . .	3,660	7 to 8 A.M.	680	13 ft.	220 ft	5 ft.	12	17	5
Second ave.	14th st.	Down . .	1,060	. . . . .	. . . .	12 ft.					
Second ave.	23d st.	Up	3,080	. . . . .	. . . .	16 ft. 6 in.					
Second ave.	23d st.	Down . .	880	. . . . .	. . . .	16 ft. 6 in.					
Third ave.	9th st.	Up	6,800	. . . . .	. . . .	15 ft.					
Third ave.	Chatham sq. .	Inter. . .	3,300	. . . . .	. . . .	13 ft.					
Sixth ave.	116th st. . . .	Inter. . .	6,460	. . . . .	. . . .	14 ft. 6 in.					
Sixth ave.	72d st.	Down . .	5,025	. . . . .	. . . .	13 ft.					
Sixth ave.	81st st.	Down . .	6,960	. . . . .	. . . .	13 ft.					
Ninth ave.	South Ferry .	Inter. . .	8,340	. . . . .	. . . .	16 ft.					
Ninth ave.	23d st.	Up	1,700	. . . . .	. . . .	13 ft.					
Ninth ave.	23d st.	Down . .	2,620	. . . . .	. . . .	13 ft.					
Ninth ave.	42d st.	Up	1,700	. . . . .	. . . .	13 ft.					

[1] 4th flight, 17.

Table XII.

AVERAGE NUMBER OF PASSENGERS IN AND OUT OF BOSTON, ON THE BOSTON & MAINE SYSTEM, DAILY (WEEK-DAYS), DURING MONTH OF AUGUST.

	Inward.	Outward.	Total, in and out.
Boston & Maine, 1884	8,420	8,249	
Eastern, 1884	7,970	7,915	
Boston & Lowell, 1884	6,494	6,239	
	22,884	22,403	45,287
Boston & Maine System, 1889	30,280	30,220	60,500
Boston & Maine System, 1893	32,848	32,059 [1]	64,907

Number taking street cars December, 1895, was 14,196.

AVERAGE NUMBER OF DAILY TRAINS IN AND OUT OF BOSTON, ON THE BOSTON & MAINE SYSTEM, DURING THE MONTH OF AUGUST.

	Outward.		Inward.		Total.	
	Passenger.	Freight.	Passenger.	Freight.	Passenger.	Freight.
Boston & Maine, August, 1884	50	7	50	7	100	14
Boston & Maine, August, 1889	65	9	65	9	130	18
Boston & Maine, August, 1893	75	11	75	11	150	22
Eastern, August, 1884	60	9	60	8	120	17
Eastern, August, 1889	64	9	64	9	128	18
Eastern, August, 1893	70	9	70	9	140	18
Boston & Lowell, August, 1884	49	9	50	8	99	17
Boston & Lowell, August, 1889	78	13	78	13	156	26
Boston & Lowell, August, 1893	89	16	89	16	178	32

APPENDIX G.

ANALYSIS OF SPRING-WATER FROM PUBLIC GARDEN PUMP-WELL.

HARVARD MEDICAL SCHOOL, CHEMICAL LABORATORY,
BOSTON, July 27, 1895.

Water Analysis.

(Figures express parts per 100,000 of water.)

WATER FROM THE BOSTON TRANSIT COMMISSION.

Location.	Free ammonia.	"Albuminoid" ammonia.	Chlorine.	Residue.			Hardness.
				Fixed.	Volatile.	Total.	
Subway, cor. Charles and Boylston streets	0.1040	0.0108	7.25	124.60	21.50	146.10	Excessive.
Date of Reception	July 23.						
Transparency	Clear.						
Color	None.						
Odor	None.						
Characteristics on ignition	No blackening.						
Nitrates	0.760						

Remarks: This water is highly contaminated with sewage. It also contains a large proportion of the salts found in sea-water.

(Signed) EDWARD S. WOOD.